

AIDS
TO
ANATOMY

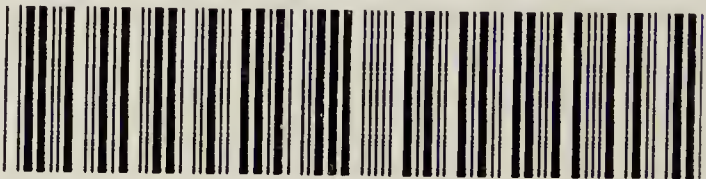


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AIDS TO ANATOMY.

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PREFACE TO THE SEVENTH EDITION.

THAT this little book should have so kept up its reputation as to have run through six editions, has decided us to launch forth a seventh, in full confidence that it will be as successful as its predecessors.

Its old friends will find it considerably altered, we hope for the better. Much new matter has been added and the sections gathered together into different groups, according to the region of the body to which they belong.

We cordially thank students for their support, and we trust that our little volume, now double its original size, will be to them doubly useful.

G. B.
P. M Y.

September, 1894.

PREFACE TO THE SIXTH EDITION.

It is highly gratifying that after having been before the student world, both in this country and the United States, for fourteen years, this little work should still retain its popularity as an aid to students who are preparing for anatomical examinations, more particularly those of the conjoint boards of the Royal Colleges of Physicians and Surgeons in England and Scotland, especially as the success of this little work has called forth others of a somewhat similar character.

I have to thank correspondents for hints as to a few necessary alterations and corrections, and to those who have suggested additions, I may say that I am preparing a further series of Aids, which I hope to complete shortly.

G. B.

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INTRODUCTION.

THE object of these Aids is to present to the student of anatomy, in a more compact and tabulated form than is usually seen, some of those facts which he has to know by heart before he can go up for examination. The more important of these facts are so grouped that the mind may readily grasp and retain them.

No attempt has been made to put forward these Aids as original, a few only can be said to be so. Some were copied from anatomical works, others from dissecting-room slates, and many are published owing to the kindness of gentlemen connected with the dissecting-rooms of other hospitals.

No greater mistake can be made than to imagine that such a book as this will render dissection unnecessary. In anatomy nothing can ever take the place of actual practical work, and the student who ventures to present himself for his anatomical examinations with nothing more than book knowledge must not complain if he meets with the fate his temerity rightly deserves.

The surgical importance of certain facts has been duly noted where it was judged necessary.

AIDS TO ANATOMY.

Section I.—THE HEAD AND NECK.

1. THE SCALP.

THE soft parts covering the cranium are divisible into five layers :

1. Skin.
2. Subcutaneous fatty tissue.
3. Occipito-frontalis aponeurosis and muscle.
4. Subaponeurotic tissue.
5. Pericranium.

The first three of these layers together form the *scalp*. The skin is thicker here than in any other part, and closely bound to the subcutaneous tissue and aponeurosis. The scalp is very vascular, the vessels being contained in the subcutaneous tissue, and closely connected therewith ; they freely anastomose.

Arteries of the scalp :

1. Frontal.
2. Supra-orbital.
3. Superficial temporal.
4. Posterior auricular.
5. Occipital.

Nerves of the scalp.—If a line be drawn across the head just in front of the external auditory meatuses, it will be found that all the scalp in front of the line will be supplied by cranial nerves, and all that behind by spinal nerves,

with one exception (Arnold's branch of the pneumogastric).

The cranial nerves supplying the scalp are :

1. Supra-trochlear
 2. Supra-orbital
 3. Temporo-malar of second division of fifth.
 4. Auriculo-temporal of third division of fifth.
- } of first division of fifth.

The spinal nerves supplying the scalp are :

1. Great auricular, from second and third cervical nerves.
2. Small occipital, from second cervical nerve.
3. Great occipital, from posterior primary division of second cervical nerve.

The veins of the scalp.—1. The supra-trochlear and supra-orbital open into the angular.

2. The superficial temporal unites with the middle temporal to form the common temporal vein, which opens into the temporo-maxillary.

3. The posterior auricular empties into the external jugular.

4. The occipital veins open into the deep cervical vein.

2. THE VENOUS SINUSES OF THE CRANIUM

are channels formed within the substance of the dura mater. They are divisible into two groups:

A.—Supero-posterior Group.

1. *Superior longitudinal* lies in the convexity of the falx cerebri. From the foramen cæcum to the lateral sinus of one side (usually right), grooving the frontal, parietal, and occipital bones. Three-sided in form, with the *chordæ Willisii* stretching across it. It receives the superior cerebral veins, which open against the blood current in the sinus (*i.e.*, their mouths look anteriorly).

2. *Inferior longitudinal sinus*, very small, lies in the concavity of the falx cerebri for its posterior half. Opens into straight sinus. Receives branches from falx and mesial surface of hemispheres.

3. *Straight sinus*, continuous with inferior longitudinal, runs backwards and downwards along junction of falx cerebri and tentorium cerebelli to internal occipital pro-

tubercle, and joins opposite lateral sinus to that which is joined by superior longitudinal. Is connected with torcular Herophili by a cross branch. Receives veins of Galen, superior cerebellar, and tentorial veins.

4. *Lateral sinuses*, one on either side, are contained in the attached margin of the tentorium cerebelli for part of their extent. They groove the occipital, parietal, temporal, and jugular processes of the occipital bones, and empty into the internal jugular veins. The one joined by the superior longitudinal sinus (usually the right) is the largest. Receives superior petrosal and occipital sinuses, posterior cerebral, superior and inferior cerebellar, and diploic veins.

5. *Occipital sinus*.—Small, sometimes double. Contained in attachment of falx cerebelli. Opens above into torcular Herophili. Below it bifurcates, each limb running round foramen magnum to join lateral sinuses. Receives branches from cerebellum.

B.—Infero-anterior Group.

1. *Cavernous sinuses*.—One on each side of body of sphenoid bone. Extend from sphenoidal tissue to apex of petrous portion of temporal bone. Named from the interlacing filaments crossing their interiors. In their outer walls lie the third, fourth, first and second divisions of fifth nerves. Lying in them (under the lining membrane) are the internal carotid arteries, the sixth nerves, and sympathetic plexuses. Receive ophthalmic and inferior cerebral veins, small branches from dura mater. Empty into superior and inferior petrosal sinuses. They communicate by the circular sinus.

2. *Circular sinus*.—A venous ring surrounding pituitary body. Formed by two transverse vessels (*anterior* and *posterior intravenous sinuses*) connecting the cavernous sinuses. May be wanting in part.

3. *Superior petrosal sinuses* groove the upper margins of the petrous bones. Pass from cavernous to lateral sinuses, in attached margin of tentorium cerebelli. Receive inferior cerebral and superior cerebellar veins and branches from tympanum.

4. *Inferior petrosal sinuses*.—Between lower borders of petrous bones and basilar process of occipital bone. From cavernous sinuses to anterior part of jugular

foramina, outside which they join the internal jugular veins. Receive inferior cerebellar veins and branches from internal ear.

5. *Transverse* or *basilar sinuses*, or *basilar plexus*.—A venous network in dura mater over basilar process of occipital bone, between inferior petrosal sinuses and anterior spinal veins.

3. THE EMISSARY VEINS OF SANTORINI

are small veins connecting the venous sinuses within the skull with the veins external. The most important are :

1. *Mastoid*, connecting lateral sinus with posterior auricular or occipital veins through mastoid foramen.

2. *Parietal*, connecting superior longitudinal sinus and veins of the scalp through parietal foramen.

3. *Posterior condylar*, connecting lateral sinus and deep cervical veins through posterior condylar foramen (not constant).

4. *Anterior condylar*, small veins with twelfth nerve connecting occipital sinus with deep cervical veins.

5. Small veins connecting cavernous sinus with pterygoid and pharyngeal plexuses and internal jugular vein through foramen ovale, foramen lacerum and carotid canal.

6. Connections between supra-orbital and deep temporal veins externally and frontal and anterior temporal diploic veins, which anastomose with posterior temporal and occipital diploic veins, which empty into lateral sinus.

7. Between ophthalmic and facial by *angular* vein, and so with cavernous sinus.

These veins are of surgical importance, inasmuch as they may cause septic meningitis and septic thrombosis by carrying septic products from the external surface.

4. THE ORBITS

are the bony cavities in the face containing the organs of vision and their accessories. Each orbit is pyramidal in shape, its base looking forwards and outwards.

Roof formed by orbital plate of frontal, and lesser wing of sphenoid bones.

Floor formed by orbital processes of malar, inferior maxillary and palate bones.

Internal wall formed by (from before backwards) nasal process of superior maxilla, internal angular process of frontal, lachrymal, ethmoid (os planum), and body of sphenoid bones.

External wall formed by external angular process of frontal, orbital process of malar, and orbital surface of great wing of sphenoid bones.

Apex is at optic foramen of sphenoid bone.

The foramina opening into it are :

1. *Optic*—transmits optic nerve and ophthalmic artery.
2. *Sphenoidal fissure*—transmits third, fourth, second division of fifth, sixth, and sympathetic nerves, and ophthalmic veins.
3. *Malar*—transmits temporo-malar of second division of fifth nerve.
4. *Anterior orbital*—transmits anterior ethmoidal vessels and nasal nerve.
5. *Posterior orbital*—transmits posterior ethmoidal vessels.
6. *Supra-orbital*—transmits supra-orbital vessels and nerve.
7. *Infra-orbital*—(by infra-orbital groove and canal) transmits infra-orbital nerve and vessels.

Communications with other cavities :

1. With *cranial* cavity by optic and orbital foramina and sphenoidal fissure.
2. With *spheno-maxillary fossa* by *spheno-maxillary fissure*.
3. With *temporal fossa* by *malar canals*.
4. With *nasal cavity* (inferior meatus) by *lachrymal* groove, lodging lachrymal sac and nasal duct.

Contents.—The orbit is lined by periosteum, and contains the following structures :

a. Muscles—

1. Levator palpebræ superioris.
2. Obliquus superior.
3. Obliquus inferior.
4. Rectus superior.

5. Rectus inferior.
6. Rectus externus.
7. Rectus internus.
8. Tensor tarsi.
9. Orbitalis.

b. Vessels.—The ophthalmic artery and its branches :

1. Lachrymal.
2. Arteria centralis retinae.
3. Supra-orbital.
4. Posterior
5. Long
6. Anterior
7. Anterior
8. Posterior
9. Palpebral.
10. Nasal.
11. Frontal.

c. Nerves—

1. Second or optic.
2. Third or motor oculi.
3. Fourth or trochlear.
4. Ophthalmic division of fifth.
5. Orbital of second division of fifth.
6. Sixth or abducens.
7. Lenticular ganglion.
8. Sympathetic.

d. Other structures—

1. Eyeball.
2. Lachrymal gland.
3. Fat.
4. Lymphatics, which terminate in the internal maxillary glands.

5. POSTERIOR TRIANGLE OF NECK

is the space behind the posterior border of the sterno-mastoid muscle.

Boundaries :

In front.—Posterior border of sterno-mastoid.

Behind.—Free border of trapezius.

Base.—Upper border of middle third of clavicle.

Apex.—Meeting of anterior and posterior boundaries at occiput.

Floor (from above downwards).—Splenius capitis, levator anguli scapulæ, scalenus medius, scalenus posterior, and upper digitation of serratus magnus.

The space is covered in by the superficial and deep fascia, and at its lower part by the platysma myoides.

This triangle is subdivided into two unequal parts by the posterior belly of the omo-hyoid. The upper portion (*occipital*) has the following—

Contents :

1. Spinal accessory and superficial branches of cervical plexus of nerves.
2. Transverse cervical artery and vein.
3. Lymphatic vessels and glands (*glandulæ concatenatæ*).

The lower portion is called the *subclavian triangle*, and it is here the subclavian artery is ligatured in its third part.

Contents :

1. Descending branches of superficial part of cervical plexus.
2. Brachial plexus.
3. Subclavian artery and vein (third part)
4. Transverse cervical artery and vein.
5. Suprascapular artery and vein.
6. External jugular and communicating branch with cephalic vein.
7. Lymphatic vessels and glands.

6. ANTERIOR TRIANGLE OF NECK

is the space in front of the anterior border of the sterno-mastoid muscle.

Boundaries :

In front.—Median line of neck from chin to top of sternum.

Behind.—Anterior border of sterno-mastoid.

Above (base).—Lower border of body of lower jaw and a line continued from its angle to the mastoid process of the temporal bone.

Floor.—Formed by the following muscles : Sterno-thyroid, sterno-hyoid, thyro-hyoid, inferior and middle constrictors of pharynx ; anterior belly of digastric, stylo-hyoid, mylo-hyoid, and hyo-glossus. The floor is crossed by the anterior belly of the omo-hyoid and the posterior belly of the digastric, which subdivide the anterior triangle into three smaller ones, viz. :

A, Inferior carotid ; B, Superior carotid ; C, Sub-maxillary.

Roof.—The space is covered in by integument, superficial fascia, platysma myoides, and deep fascia. Between the layers forming the roof are the cutaneous branches of the facial (infra-maxillary branches of cervico-facial division) and superficial cervical nerves.

The contents will be enumerated in the description of the subdivisions *A, B, C*.

A.—The Inferior Carotid Triangle.

This triangle is the lowermost subdivision of the anterior triangle, and has the following boundaries :

In front.—Median line of neck.

Behind.—Anterior border of sterno-hyoid.

Above.—Anterior belly of omo-hyoid.

Floor.—Sterno-hyoid and sterno-thyroid.

Roof.—Integument, superficial fascia, platysma myoides and deep fascia, with branches of superficial cervical nerve.

Contents.—As usually dissected, this space contains the following structures :

Thyroid gland, lower part of larynx and trachea.

Veins.—Internal jugular and inferior thyroid.

Arteries.—Common carotid and inferior thyroid.

Nerves.—Pneumogastric, recurrent laryngeal, descendens cervicis, communicantes hypoglossi (*ansa hypoglossi*), and sympathetic.

In order to expose the above structures, it is necessary to turn aside the sterno-hyoid and sterno-thyroid, and a portion of the sterno-mastoid (sternal head). The common carotid is occasionally tied in the upper part of

this triangle, immediately below the omo-hyoid muscle, but more frequently the ligature is applied above the omo-hyoid in the superior carotid triangle (see below).

B.—The Superior Carotid Triangle.

This triangle is the middle of the three subdivisions of the anterior triangle. Its boundaries are :

Behind.—Anterior belly of sterno-mastoid.

Above.—Posterior belly of digastric.

Below.—Anterior belly of omo-hyoid.

Floor.—Thyro-hyoid, hyo-glossus, inferior and middle constrictors of pharynx.

Roof.—As in inferior carotid triangle, and is crossed by branches of superficial cervical and infra-maxillary nerves.

Contents :

Upper part of larynx and lower part of pharynx.

Veins.—Internal jugular, and those which open into it, viz. : Lingual, facial, superior thyroid, pharyngeal, and (sometimes) occipital.

Arteries.—Termination of common carotid, external and internal carotid, superior thyroid, lingual, facial, ascending pharyngeal, and occipital. The five last-named are branches of the external carotid.

Nerves.—Pneumogastric, superior, external and recurrent laryngeal, hypoglossal, descendens cervicis, spinal accessory, and sympathetic.

It is in this triangle that the common carotid is usually tied above the omo-hyoid, at the ‘seat of election.’

C.—The Submaxillary Triangle.

This triangle is the most superior of the three subdivisions of the anterior triangle, and has the following boundaries :

Behind.—Posterior belly of digastric.

Above.—Lower border of the jaw, and a line continued from its angle to the mastoid process.

In front.—Median line of neck from chin to hyoid bone.*

* Some anatomists limit this space in front by the anterior belly of the digastric, but the above is the better description and the one most generally in use.

Floor.—Anterior belly of digastric, mylo-hyoid, and hyo-glossus.

Roof.—As in superior and inferior carotid triangles, crossed by branches of infra-maxillary and superficial cervical nerves.

Contents :

Portion of parotid and submaxillary (salivary) glands, separated by the stylo-maxillary ligament ; submaxillary lymphatic glands and vessels.

Veins.—Internal jugular, commencement of external jugular (formed by the junction of the superficial division of the temporo-maxillary and posterior auricular, and sometimes of the occipital), radicles of anterior jugular, facial, and those which open into it below the jaw, viz. : the submental, submaxillary, inferior palatine and ranine.

Arteries.—External carotid, internal carotid, facial, submental, mylo-hyoid, and several smaller branches.

Nerves.—As usually dissected, the superficial nerves met with in this space are the mylo-hyoid (branch of inferior dental), and its branch to the anterior belly of digastric muscle. Deeply situated at the back part of the space are the pneumogastric and glosso-pharyngeal nerves. That portion of the hypoglossal nerve which lies on the hyo-glossus muscle should be included as one of the contents.

The stylo-hyoid, the stylo-glossus, origin of the stylo-pharyngeus muscles, and stylo-maxillary ligament may also be given. The stylo-hyoid is sometimes given as entering into the formation of the posterior boundary.

In this triangle the lingual artery is usually tied, where it lies under the hyo-glossus muscle.

7. SUBOCCIPITAL TRIANGLE.

This triangle is situated immediately below the occipital bone, and beneath the upper part of the complexus muscle. Its boundaries are as follows :

Above.—Obliquus superior.

Below.—Obliquus inferior.

Behind.—Rectus capitis posticus major.

The *roof* is formed by the complexus muscle, and the *floor* by the posterior occipito-atloid ligament and posterior arch of the atlas.

Contents :

Vertebral artery and suboccipital nerve (posterior primary division of first cervical).

8. STRUCTURES BENEATH THE STERNO-MASTOID.

1. Deep layer of cervical fascia.
2. Sterno-clavicular articulation with its ligaments.
3. Sternal portion of sterno-thyroid.
4. " " " sterno-hyoid.
5. Central portion of omo-hyoid.
6. Portions of scalene muscles.
7. " splenius capitis and splenius colli muscles.
8. Origin of posterior belly of digastric.
9. Portion of levator anguli scapulæ.
10. Common carotid artery in its sheath.
11. Commencement of external carotid artery with its branches.
12. Commencement of internal carotid artery.
13. Transversalis cervicis artery and vein.
14. Supra-scapular artery and vein.
15. Internal jugular vein (in carotid sheath).
16. Deep cervical (lymphatic) glands.
17. Portion of parotid gland.
18. Cervical plexus of nerves.
19. Hypoglossal nerve.
20. Descendens cervicis nerve and ansa hypoglossi.
21. Pneumogastric nerve (in carotid sheath).
22. Spinal accessory nerve.
23. Phrenic nerve.
24. Facial nerve.
25. Sympathetic nerve.

The muscle is bound to the lower border of the inferior maxilla by a process of the deep cervical fascia, so that it covers more structures in the undisturbed than in the dissected condition.

9. RELATIONS OF THE TRACHEA IN THE NECK.

Anteriorly :

1. Skin and superficial fascia.
2. Layers of deep cervical fascia.
3. Anterior jugular veins.
4. Sterno-hyoid and sterno-thyroid muscles.
5. Inferior thyroid plexus of veins.
6. Left innominate vein.
7. Thyroidea ima artery (when present).
8. Isthmus of thyroid body (crossing second, third and fourth rings).
9. Thymus gland (before two years of age).
10. At root of neck, innominate and left common carotid arteries.

Posteriorly :

1. Œsophagus.
2. Vertebral column.
3. Inferior or recurrent laryngeal nerves (in the lateral grooves between the trachea and œsophagus).

Laterally :

1. Lobes of thyroid body.
2. Common carotid arteries.
3. Inferior thyroid arteries.

Tracheotomy is done either above ('high operation') or below ('low operation') the thyroid isthmus, the former being the more frequent procedure.

10. DEEP CERVICAL FASCIA.

The deep cervical fascia binds together the structures in the neck, and is of surgical importance in that it limits the growth of tumours and abscesses in this region, and determines to a great extent their direction. It is divisible into a superficial layer and deep processes.

A.—The Superficial Layer

completely invests the neck, and covers in all structures except the superficial veins and nerves and the platysma myoides. Starting behind at the vertebral

spinous processes, it splits to enclose the trapezius, roofs in the posterior triangle (as a single layer), invests the sterno-mastoid, and roofs in (again as a single layer) the anterior triangle, meeting the fascia of the opposite side at the middle line of the neck. Its attachments are :

Above :

1. Superior curved line of occipital bone.
2. Mastoid process.
3. Border of lower jaw.
4. Zygoma, enclosing parotid gland (*parotid fascia*).
5. Base of skull (separating parotid and submaxillary glands, and in part forming the stylo-maxillary ligament).
6. Hyoid bone.

Below :

1. Clavicle.
2. Manubrium sterni (by two layers, to front and back respectively, enclosing anterior jugular vein).

B.—The Deeper Processes.

1. One passing across from just in front of anterior border of sterno-mastoid, beneath depressor muscles of hyoid bone, investing thyroid body and front of trachea, and joining fibrous layer of pericardium.

2. *Prevertebral fascia*, passing between œsophagus and prevertebral muscles, attached above to the base of the skull, continued below into the thorax. Laterally it joins the carotid sheath, and is prolonged over the scalene muscles, brachial plexus and axillary vessels, forming axillary sheath, and blending with the costo-coracoid membrane (see p. 81). This process forms also the pharyngeal fascia.

3. *The carotid sheath* is derived from both these deeper processes of the fascia.

11. STRUCTURES ON THE MYLO-HYOID MUSCLE.

1. Anterior belly of digastric.
2. Superficial portion of submaxillary gland.
3. Facial vessels with submaxillary and submental branches.

4. Mylo-hyoid artery (branch of inferior dental from first part of internal maxillary) and vein.
5. Mylo-hyoid nerve (branch of inferior dental from third division of fifth nerve).

12. STRUCTURES BENEATH THE MYLO-HYOID MUSCLE.

1. Sublingual gland.
 2. Deep process of submaxillary gland.
 3. Wharton's duct (of submaxillary gland).
 4. Sublingual artery.
 5. Ranine artery.
 6. Lingual nerve (from third division of fifth nerve).
 7. Hypoglossal nerve.
 8. Submaxillary ganglion.
 9. Genio-hyoid
 10. Genio-hyo-glossus
 11. Hyo-glossus
 12. Stylo-glossus
- } muscles.

13. STRUCTURES ON THE HYO-GLOSSUS MUSCLE.

1. Deep part of submaxillary gland.
 2. Lingual nerve.
 3. Wharton's duct.
 4. Hypoglossal nerve.
 5. Submaxillary ganglion.
 6. Digastric
 7. Stylo-hyoid
 8. Stylo-glossus
 9. Mylo-hyoid
- } muscles.

14. STRUCTURES BENEATH THE HYO-GLOSSUS MUSCLE.

1. Lingual artery and veins with dorsal branches.
 2. Glosso-pharyngeal nerve.
 3. Stylo-hyoid ligament.
 4. Genio-hyo-glossus
 5. Superficial lingualis
 6. Middle constrictor of pharynx
- } muscles.

NOTE.—All the structures going to the tongue pass either under or over the hyo-glossus muscle.

15. THE MUSCLES OF THE TONGUE.

A.—Extrinsic.

Four on each side :

1. *Genio-hyo-glossus*.—Fan-shaped, placed with fellow in median plane. *Arises* from superior mental spine of jaw. *Inserted* into body of hyoid bone, side of pharynx, and whole length of tongue to tip. *Action* : Hinder part protrudes, fore part retracts, and middle part depresses tongue.

2. *Hyo-glossus*.—Flat and quadrate. *Arises* from great cornu and lateral part of body of hyoid bone. *Inserted* into dorsum of tongue, joining fibres of stylo-glossus. *Action* : Retractor and depressor.

3. *Chondro-glossus*.—Small flattened slip (sometimes described as part of hyo-glossus). *Arises* from small cornu and part of body of hyoid bone. *Inserted* into dorsum of tongue by side of middle line. *Action* : Retractor and depressor. (This muscle is inconstant.)

4. *Stylo-glossus*.—*Arises* from front of styloid process near tip and stylo-maxillary ligament. *Inserted* along side and under part of tongue as far as tip, fibres decussating. *Action* : Draws tongue backwards and elevates its base (as in deglutition).

B.—Intrinsic.

Three on each side :

1. *Transversalis*.—A horizontal layer of muscular fibre passing from base to apex. *Arises* from the septum. *Inserted* into side of tongue. *Action* : Both working together make the tongue narrower, longer and rounder.

2. *Superior lingualis*.—Lies close under mucous membrane, on dorsum of tongue. *Arises* from frænum epiglottidis and fibrous tissue along middle line. *Inserted* into margin of tongue. *Action* : Both together shorten tongue, and bend it upwards and backwards.

3. *Inferior lingualis*.—Lies under tongue, between hyo-glossus and genio-hyo-glossus. *Arises* from fascia at root. Fibres pass up to dorsum through transversalis. *Action* : Both together shorten tongue and bend it downwards and backwards.

Nerves.—Both the extrinsic and intrinsic muscles of tongue are supplied by the hypo-glossal (twelfth) nerve.

16. MUSCLES OF THE FACE.

The muscles of the face may be divided into those of the nose, eyelids, and mouth.

A.—Muscles of the Nose.

Six in number :

1. *Pyramidalis nasi* (a prolongation of the frontalis).—*Arises* from skin of lower and mesial part of forehead. *Inserted* into skin of nose with next muscle. *Action* : Wrinkles skin at root of nose.

2. *Compressor naris*.—*Arises* from superior maxilla at margin of anterior nares. *Inserted* into skin of nose with last muscle. *Action* : As its name implies.

3. *Levator labii superioris alaeque nasi*.—*Arises* from nasal process of superior maxilla. *Inserted* into wing of nose and skin of upper lip. *Action* : As its name implies.

4. *Depressor alae nasi*.—*Arises* from incisor fossa of superior maxilla. *Inserted* into septum and ala nasi. *Action* : As its name implies.

5 and 6. *Dilatores naris anterior and posterior*, are small indistinct bundles of muscular fibre attached to the small cartilages of the nose and the skin.

B.—Muscles of the Eyelids.

Four in number :

1. *Orbicularis palpebrarum*.—The *Palpebral* portion is contained in the eyelids, *arising* from the internal, and *inserted* into the external tarsal ligament. The fibres at the free margin of each lid form the *ciliary* bundle. The *orbital* portion *arises* from inner part of tarsal ligament, nasal process of superior maxilla, and inner part of orbital arch of frontal bone. From thence the fibres pass to the cheek, forming loops. *Action* : The palpebral part closes the lids, the orbital part depresses eyebrow and raises the skin of cheek.

2. *Tensor tarsi*.—*Arises* from lachrymal crest, and passes in two slips behind the lachrymal canals to the ciliary bundles of orbicularis. *Action* : Compresses lachrymal sac.

3. *Corrugator supercilii*.—*Arises* from superciliary

ridge of frontal. *Inserted* into skin of eyebrow. *Action*: The frowning muscle.

4. *Levator palpebræ superioris*.—*Arises* above and in front of optic foramen. *Inserted* into upper tarsal cartilage. *Action*: As its name implies.

C.—Muscles of the Lips and Mouth.

Ten in number:

1. *Levator labii superioris*.—*Arises* from superior maxilla (just below infra-orbital foramen) and malar bone. *Inserted* into skin of upper lip. *Action*: As its name implies.

2. *Levator anguli oris*.—*Arises* in canine fossa of superior maxilla. *Inserted* into skin at angle of mouth, decussating with depressor anguli oris. *Action*: As its name implies.

3 and 4. *Zygomatici major and minor*.—*Arise* from malar bone. *Inserted* into skin of lip and angle of mouth. *Action*: Elevate upper lip and angle of mouth.

5. *Risorius* (of Santorini).—*Arises* from fascia over masseter. *Inserted* into angle of mouth. *Action*: As its name implies.

6. *Buccinator*.—*Arises* from outer part of alveolar margins of upper and lower jaws (opposite molar teeth) and pterygo-maxillary ligament. *Inserted* by blending with orbicularis oris. *Action*: Regulates forced expulsion of air, and keeps food between the teeth.

7. *Depressor anguli oris (triangularis menti)*.—*Arises* from external oblique line of lower jaw. *Inserted* into angle of mouth. *Action*: As its name implies.

8. *Depressor labii inferioris (quadratus menti)*.—*Arises* from lower jaw below mental foramen. *Inserted* into lower lip. *Action*: As its name implies.

9. *Levator labii inferioris (levator menti)*.—*Arises* from incisor fossa of lower jaw. *Inserted* into skin over chin. *Action*: Draws up skin over chin and protrudes lower lip.

10. *Orbicularis oris* is formed mostly of fibres from the buccinator and elevator and depressor muscles of angle of mouth. True orbicular fibres do not exist. *Action*: Draws lips together in vertical and transverse directions.

Nerves.—All these muscles (except the levator palpebræ superioris, which really belongs to the muscles of the orbit) are supplied by the facial (seventh) nerve. They are all concerned in the production of expression.

NOTE.—These muscles (with the exception of the buccinator and levator palpebræ superioris) are vestiges of the *panniculus carnosus*, a subcutaneous muscular sheet found in the lower animals. Other remains in man of this muscular investment are the occipito-frontalis, extrinsic and intrinsic auricular muscles, platysma myoides, palmaris brevis, corrugator cutis ani, and a few fibres sometimes seen on the pectoralis major and deltoid muscles.

17. STRUCTURES OF THE EYELIDS.

The eyelids are composed of the following structures in the order given from without inwards :

1. Skin and loose subcutaneous tissue.
2. Orbicularis palpebrarum muscle.
3. Palpebral ligament.
4. Tendon of levator palpebræ (upper lid only).
5. Tarsal cartilage.
6. Meibomian glands.
7. Conjunctiva.

18. THE LACHRYMAL APPARATUS

consists of the lachrymal gland and its ducts, puncta lachrymalia, lachrymal canals, lachrymal sac and nasal duct.

Lachrymal gland.—Size and shape of an almond, lying in lachrymal fossa under external angular process of frontal bone. Opens by eight or ten ducts into fornix of conjunctiva. It has the structure of a salivary gland.

Puncta lachrymalia are pin-point openings situated on the summits of the *papillæ lachrymalia*, at the inner ends of the margins of the lids close to the caruncle. They lead to the

Lachrymal canals, which run first vertically, then horizontally, into the lachrymal sac; they are kept in contact with the eyeball by the tensor tarsi muscle.

The lachrymal sac is the dilated end of the nasal

duct, and lies in the groove between the lachrymal bone and nasal process of superior maxilla.

The nasal duct is composed of fibrous tissue. It is $\frac{3}{4}$ inch long, and opens into the inferior meatus of the nose; its direction is downwards, outwards, and backwards.

NOTE.—It is of importance to remember the direction of the nasal duct when passing a probe.

19. THE PAROTID GLAND.

The parotid gland is a compound racemose gland, mainly situated behind the ramus of the lower jaw, and derives a dense capsule from the deep cervical fascia, this capsule communicating with the pharyngeal connective tissue.

The gland has three *processes* :

1. *The socia parotidis*, lying on the masseter muscle.
- 2 and 3. *Deep processes*, behind the ramus of the lower jaw, one in front of and one behind the styloid process.

The *relations* of the gland are of surgical importance.

Above :

1. External auditory meatus.
2. Zygoma.
3. Temporal muscle.

Below :

1. The submaxillary gland, separated from it by the stylo-maxillary ligament.

Behind :

1. Mastoid process and muscles attached thereto.
2. Occipital and posterior auricular arteries.

In front :

1. Ramus of lower jaw.
2. Temporo-maxillary joint.

Externally :

1. Skin and fascia.
2. Parotid lymphatic glands.

Internally :

1. Internal jugular vein.
2. Internal carotid artery.
3. Pneumogastric nerve.
4. Auriculo-temporal nerve.
5. Stylo-maxillary ligament.

Structures passing through parotid gland :

1. External carotid artery and its terminal branches (superficial temporal and internal maxillary).
2. Commencement of external jugular vein (temporal and internal maxillary veins).
3. Facial nerve.
4. Offsets of great auricular nerve communicating with facial nerve.
5. Transverse facial artery emerges from it in front.

The duct of Stenson emerges from the socia parotidis, crosses the masseter muscle, and, dipping inwards, enters the mouth opposite the second upper molar tooth. It is about $2\frac{1}{2}$ inches long, and has the transverse facial artery above it and the facial nerve below it. It is composed of two coats, an outer fibrous and an internal mucous coat lined with columnar epithelium.

20. STRUCTURES WHICH LIE ON THE MASSETER MUSCLE.

1. Socia parotidis.
2. Stenson's duct.
3. Transverse facial artery and vein.
4. Facial vein.
5. Branches of facial nerve.

The muscle is covered by integumentary structures, and, for its lower half, by the *plastysma myoides*. The facial artery winds over the lower jaw at its anterior inferior angle.

21. LYMPHATIC GLANDS OF THE HEAD AND NECK.

- The lymphatic glands, and the regions from which they receive their lymph, are important surgically from the fact of their enlargement in certain diseases.

A.—Of the Head.

These are comparatively few and small :

1. *Occipital*.—One or two under the skin over the upper end of the complexus muscle. *Receive* lymphatics from hinder part of scalp, and *communicate* with the superficial cervical glands.
2. *Mastoid*.—Two or three over insertion of sterno-

mastoid. *Receive* lymphatics from scalp behind ear. *Communicate* with superficial cervical glands.

3. *Parotid*.—Three or four under parotid fascia, in substance of gland. One just in front of tragus. *Receive* lymphatics from temporal region. *Communicate* with superficial cervical and submaxillary lymph glands.

4. *Internal maxillary*.—Deep beneath ramus of jaw, one or two on internal maxillary artery, some on buccinator and side of pharynx. *Receive* lymphatics from temporal, zygomatic and orbital fossæ, roof of mouth and soft palate. *Communicate* with superior deep cervical glands.

B.—Of the Neck.

These are large and numerous :

1. *Submaxillary*.—Eight to ten beneath base of lower jaw. *Receive* lymphatics from face, floor of mouth, submaxillary and sublingual salivary glands, and from parotid lymph glands. *Communicate* with superficial and deep cervical glands.

2. *Suprahyoid*.—One or two in centre of neck between anterior bellies of digastric muscles. *Receive* lymphatics from lower lip.

3. *Superficial cervical*.—Four to six along external jugular vein, under platysma and deep fascia. *Receive* lymphatics from external ear, integument of neck, from suboccipital, mastoid, parotid, and submaxillary lymph glands. *Communicate* with deep cervical glands. Those along the posterior border of the sterno-mastoid are called *glandulæ concatenatæ*.

4. *Deep cervical*.—Twenty to thirty in two main groups—

a. *Superior* from bifurcation of common carotid artery to base of skull, along internal jugular vein. *Receive* lymphatics from cranial cavity, tongue, larynx, lower part of pharynx, and some from thyroid body and deep muscles of neck, and from internal maxillary and submaxillary lymph glands. *Communicate* with deep cervical glands.

b. *Inferior*.—Round lower part of internal jugular vein, extending into supraclavicular fossa, and continuous with superior mediastinal and axillary glands. *Receive* lymphatics from lower part of neck and the

other cervical glands (superficial and deep). *Communicate* with thoracic (or right lymphatic) duct by their efferent vessel, the *jugular lymphatic trunk*.

22. THE SOFT PALATE.

The soft palate (*velum pendulum palati*) is the name given to the fold of mucous membrane, with its contained muscles, situate at the posterior part of the mouth, and continuous with the hard palate. From the middle of its free border depends the *uvula*; on each side are two curved folds of mucous membrane, the *pillars of the fauces*. The two pillars are closely united above, but below they are separated by a triangular interval which lodges the tonsil. The *anterior pillar* terminates at the side of the base of the tongue, and is formed by the prominence of the palato-glossus muscle. The *posterior pillar* extends downwards and backwards into the pharynx, and is formed by the convexity of the palato-pharyngeus muscle. Between the soft palate and the root of tongue is the opening from the mouth into the pharynx, or *isthmus of the fauces*. Its boundaries are :

Above.—Soft palate.

Below.—Root of tongue.

Laterally.—Pillars of the fauces and tonsils.

In dissecting the soft palate from behind forwards, the following structures are met with :

1. Mucous membrane.
2. Submucous tissue, glands, vessels, etc.
3. Palato-pharyngeus muscle (posterior fasciculi).
4. Levator palati and azygos uvulæ muscles.
5. Palato-pharyngeus (anterior fasciculi).
6. Aponeurosis of tensor palati muscle.
7. Palato-glossus muscle.
8. Submucous tissue, glands, vessels, etc.
9. Mucous membrane.

23. THE PHARYNX.

The pharynx is about 5 inches long, wider from side to side than from before backwards; widest (2 inches) at level of great cornua of hyoid bone, narrowest (less than $\frac{3}{4}$ inch) opposite cricoid cartilage. It has an internal mucous, a middle muscular, and an external fibrous

coat, being invested by the *pharyngeal fascia* (part of the deep cervical fascia ; see p. 21). The muscles forming its middle coat are :

1. *Inferior constrictor*, arising from the side of the cricoid cartilage and the oblique line and upper tubercle of the thyroid cartilage.

2. *Middle constrictor*, arising from the large and small cornua of the hyoid bone and the stylo-hyoid ligament.

3. *Superior constrictor*, arising from the side of the tongue, mucous membrane of mouth, extremity of mylo-hyoid ridge of lower jaw, pterygo-maxillary ligament, and hamular process, and part of posterior border of internal pterygoid plate.

The three constrictors are all inserted into a median raphé, each one overlapping its fellow above. The inferior constrictor sends some fibres to the longitudinal muscle coat of the œsophagus, and the superior is inserted above into the pharyngeal spine of the basilar process of the occipital bone, leaving a gap between its upper border and that process (*sinus of Morgagni*), closed by fibrous tissue, through which pass the levator palati, Eustachian tube, and ascending pharyngeal artery.

4. *Stylo-pharyngeus*, arising from the inner part of the root of the styloid process, inserted into the lateral wall of the pharynx (under middle constrictor) and superior and posterior borders of the thyroid cartilage.

The pharynx has the following relations—

Behind :

- | | |
|------------------------------|------------|
| 1. Vertebral column. | |
| 2. Longus colli | |
| 3. Recti capiti antici major | } muscles. |
| 4. Prevertebral fascia. | |

In front :

1. Posterior nares.
2. Mouth.
3. Tongue.
4. Hyoid bone.
5. Larynx.

Laterally :

1. Sterno-mastoid muscles.
2. Lobes of thyroid body.

3. Common, external, and internal carotids.
4. Lingual artery.
5. Internal jugular vein.
6. Pneumogastric, glosso - pharyngeal, and hypoglossal nerves.

There are seven *openings* into the pharynx :

In front :

1. } Posterior nares.
2. }
3. Mouth.

Laterally :

4. } Eustachian tubes.
5. }

Below :

6. Larynx.
7. Œsophagus.

Behind the opening of each Eustachian tube is the *fossa of Rosenmüller*, and stretching across the posterior wall at this level is a mass of lymphoid tissue, the *pharyngeal tonsil*.

24. VARIETIES OF ARTICULATIONS.

As the different articulations met with in the body will be described with the regions to which they belong, a brief general description of their various forms is best given here before discussing those of the head and face.

Articulations are classified as **synarthrodial** and **diarthrodial**, according to whether the surfaces of bone entering into their formation are immovably bound together or not. Each of these classes has subdivisions, now to be enumerated :

A.—Synarthrosis.

The adjacent osseous surfaces united by some interposed substance.

1. *Synchondrosis*.—Thin layer of cartilage between the bones, to which it adheres closely on each side. Is of

a transitory nature, being usually converted into bony union (*synostosis*) before adult age is reached.

Example.—Articulation between sphenoid and basilar process of occipital bones.

2. *Suture*.—Bones separated only by fibrous tissue, continuous with periosteum. Only met with in skull. Tend to synostosis, but later than in synchondroses. They are classed as follow :

(a) *Sutura serrata* or *dentata*, in which the bones fit closely by serrated or dentated edges.

Example.—Coronal suture.

(b) *Sutura squamosa*, in which the bony edges are bevelled to overlap one another, scale-fashion.

Example.—Squamo-parietal suture.

(c) *Sutura harmonia*, in which the opposed bony surfaces are comparatively smooth or simple edges.

Example.—Vertical plate of palate and superior maxilla.

(d) *Schindylesis*, or *grooved suture*, in which one bone fits into a groove in the other.

Example.—Vomer and sphenoid.

3. *Symphysis*.—Bones united by plate or disc of cartilage, thick, and of more or less complex structure.

Example.—Symphysis pubis.*

4. *Syndesmosis*.—Bones united by an interosseous ligament.

Example.—Inferior tibio-fibular articulation.

Movement.—Synchondroses and sutures are immovable, but a certain amount of movement is permitted in symphyses and syndesmoses.

B.—Diarthrosis.

Articular parts of bones covered with cartilage, and lubricated by a synovial membrane. Bones united by fibrous tissue or ligaments (capsules, flat bands, round cords). When the opposed surfaces correspond in shape and curvature they are called *congruent*; when they differ in form, *incongruent*. A *compound* diarthrodial joint differs from a *simple* one in having an *interarticular fibro-cartilage* or *meniscus* interposed between its bony

* This form is sometimes grouped as a third primary division, and called *amphiarthrosis*.

surfaces. The following are the different forms of diarthrosis :

1. *Arthrodia* (*gliding joint*), as in joints between vertebral articular processes.
2. *Ginglymus* (*hinge-joint*), as in elbow-joint.
3. *Condylarthrosis* (*condyloid joint*), as in metacarpophalangeal joint.
4. *Saddle-joint*, as in thumb metacarpal and trapezium.
5. *Enarthrosis* (*Ball and socket joint*), as in shoulder and hip.
6. *Trochoides* (*pivot-joint*), as in radio-ulnar articulations.

NOTE.—The fixation of the teeth in the jaws is not a true articulation, but is described by some anatomists as such, in which case it is included, under the name *gomphosis*, among the synarthrodial articulations.

25. ARTICULATIONS OF THE HEAD AND NECK.

Those of the cervical vertebræ, atlas, axis, and occipital bone will be found in Section IV. (p. 80).

(a) *The sutures of the skull*.—The sutural articulations have been explained in the preceding subsection, and need not be discussed further.

(b) *Temporo-maxillary articulation*.

Variety.—A diarthrodial joint, compound and incongruent.

Movements allowed.—The jaw is capable of movements of elevation, depression, protrusion, and retraction, a combination of which produces grinding movement.

Bones concerned :

1. Condyle of lower jaw (axis directed from without inwards and backwards).
2. Glenoid fossa and eminentia articularis of temporal bone. These surfaces are markedly incongruent, which is compensated by the interposition of a meniscus.

Ligaments :

1. *External lateral* from lower border and tubercle of zygoma to external surface and posterior border of neck of condyle of lower jaw.
2. *Internal lateral*, flat and thin, at some distance from the joint. From spinous process of sphenoid to lingula

and lower border of inferior dental foramen. Between it and lower jaw are :

1. External pterygoid muscle.
2. Internal maxillary vessels.
3. Auriculo-temporal nerve.
4. Inferior dental vessels and nerve.

3. *Capsular*.—A few scattered fibres covering the synovial membrane in front, inside and behind.

4. *Stylo-maxillary*. — Band of cervical fascia from styloid process to angle and posterior border of ramus of jaw, and separating parotid and submaxillary glands.

5. *Interarticular fibro-cartilage*. — Thin oval plate, broadest transversely, thickest posteriorly, thinnest (may be perforated) in centre. Concave inferiorly, concavo-convex from before backwards superiorly. Attached to capsule by its circumference. Internal pterygoid muscle attached to it in front.

Synovial sacs.—One above and one below meniscus, the former being the larger. May communicate through centre of cartilage.

Blood supply from masseteric artery (from internal maxillary) and the vessels in the parotid gland.

Nerve supply from masseteric and auriculo-temporal of third division of fifth.

Relations :

Externally.—Skin, fasciæ, parotid gland.

Internally — Tympanum and internal ear, external pterygoid muscle, internal maxillary, and inferior dental vessels, auriculo-temporal and inferior dental nerves.

Behind. — External auditory meatus, parotid gland, external carotid artery and its terminal branches.

In front. — Masseteric vessels and nerves, internal pterygoid muscle.

NOTE.—The relations of the temporo-maxillary joint are of surgical importance.

26. ERUPTION OF THE TEETH.

Temporary.—The times of the eruption of the milk teeth are to be reckoned in *months*:

Central incisor, 6 to 7.

Lateral „ 8 to 9.

Canines,	18.
First molar,	12.
Second „	24.
<i>Permanent, to be reckoned in years—</i>	
Central incisor,	7.
Lateral „	8.
Upper canine,	11.
Lower „	12.
First bicuspid,	9.
Second „	10.
First molar,	6.
Second upper molar	12.
Second lower „	13.
Third upper „	17.
Third lower „	25.

The eruption of the third molar or 'wisdom' teeth is sometimes delayed until after the age of thirty.

Section II.—THE THORAX.

1. THE THORAX

is the superior cavity of the trunk, and contains the lungs, heart, great vessels, parts of the trachea and œsophagus, the bronchi, etc.

Boundaries.

Behind.—Vertebral column and posterior parts of the ribs, with parts of intercostal muscles.

In front.—Sternum, costal cartilages and parts of intercostal muscles.

Below.—Diaphragm.

2. STRUCTURES BETWEEN THE CLAVICLE AND FIRST RIB.

1. Rhomboid ligament.
2. Subclavius muscle.
3. Lymphatic vessels.
4. Subclavian artery.
5. Subclavian vein.
6. Cords of the brachial plexus of nerves.
7. Posterior thoracic nerve, or external respiratory of Bell.*
8. External anterior thoracic nerve (occasionally).

NOTE.—These relations are of surgical importance on

* The *internal respiratory of Bell* is the *phrenic* nerve.

account of fractures of the clavicle and other injuries about its region.

3. STRUCTURES FOUND IN AN INTERCOSTAL SPACE.

From without inwards these are :

1. External intercostal muscle (fibres run downwards and forwards).

2. Intercostal artery, vein, and nerve (lying in the groove on the inferior border of the superior rib of the space ; the vein lies above, the nerve below the artery).

3. Internal intercostal muscle (fibres run downwards and backwards).

NOTE.—The intercostal spaces are of surgical importance in the operations of excision of a piece of rib, aspiration, and of draining the pleural cavity.

4. STRUCTURES PASSING THROUGH THE SUPERIOR APERTURE OF THORAX.

1. Right and left sterno-hyoid
2. „ „ „ sterno-thyroid
3. „ „ „ longus colli
4. Trachea.
5. Œsophagus.
6. Thoracic duct (on left side).
7. Superficial lymphatic vessels of liver and lymphatic vessels of right side of chest.
8. Innominate artery (right side).
9. Left common carotid artery.
10. Left subclavian artery.
11. Right and left internal mammary arteries.
12. „ „ „ superior intercostal arteries.
13. Thyroidea ima artery (when present).
14. Right and left innominate veins.
15. „ „ „ inferior thyroid veins.
16. „ „ „ phrenic nerves.
17. „ „ „ pneumogastric nerves with cardiac branches.
18. Left recurrent laryngeal nerve.
19. Right and left sympathetic nerves with cardiac branches.
20. Right and left first dorsal nerves.

21. Remains of thymus gland.
22. Apices of lungs and pleuræ.
23. Deep cervical fascia passing on to pericardium.

5. THE MEDIASTINA.

The mediastina are the spaces in the middle line of the thorax, formed by the approximation of the pleura on either side, and extend from the sternum in front to the bodies of the vertebræ behind. In no place do the reflected pleuræ come in contact with each other, so that the space between them forms a complete septum, dividing the two pulmonary cavities.

The mediastina are four in number: *A*, anterior mediastinum; *B*, middle mediastinum; *C*, posterior mediastinum; *D*, superior mediastinum, and contain all the viscera of the chest, with the exception of the lungs. The boundaries and contents of the four divisions are as follows :

A.—Anterior Mediastinum.

Boundaries :

In front.—The sternum and adjoining parts of fifth, sixth, and seventh costal cartilages.

Behind.—Pericardium.

Laterally.—Pleuræ.

This space inclines to the left.

Contents :

1. Origins of sterno-hyoid muscles.
2. Origins of sterno-thyroid muscles.
3. Triangularis sterni muscle, covering the anterior boundary, and shutting off
4. The left internal mammary artery and venæ comites.
5. Remains of thymus gland.
6. Loose areolar tissue, and some lymphatic glands associated with the mamma.
7. Lymphatic vessels from convex surface of liver.

NOTE.—The right internal mammary vessels, being covered by pleura, are not included among the contents of the space.

B.—Middle Mediastinum.

Boundaries :

In front.—Anterior mediastinum.

Behind.—Posterior mediastinum.

Laterally.—Pleuræ.

Contents :

1. The heart and pericardium.
2. Ascending part of aorta.
3. Superior vena cava.
4. Bifurcation of trachea.
5. Roots of the lungs.
6. Phrenic nerves (from third, fourth, and fifth cervical), and the accompanying branches of the internal mammary artery (*comites nervi phrenici*).
7. Vena azygos (turning over root of right lung).

C.—Posterior Mediastinum.

Boundaries :

In front.—Pericardium and roots of lungs.

Behind.—Vertebral column.

Laterally.—Pleuræ.

Contents :

1. Descending aorta.
2. Venæ azygos major and minor.
3. Superior intercostal veins.
4. Pneumogastric nerves.
5. Sympathetic nerves, with their splanchnic offsets.
6. Œsophagus.
7. Thoracic duct.
8. Lymphatic glands and vessels.

D.—Superior Mediastinum

is that space between the pleuræ which is situated above a horizontal plane passing from the junction between the manubrium and gladiolus of the sternum to the lower border of the fourth dorsal vertebra.

Boundaries :

In front.—Manubrium sterni.

Behind.—Third and fourth dorsal vertebræ.

Laterally.—Pleuræ.

Contents :

1. Origins of sterno-hyoid and sterno-thyroid muscles.
2. Remains of thymus gland.
3. Trachea.
4. Œsophagus.
5. Thoracic duct.
6. Arch of aorta with its branches (innominate, left common carotid and left subclavian arteries).
7. Innominate veins and beginning of superior vena cava.
8. Phrenic, pneumogastric and cardiac nerves.
9. Left recurrent laryngeal nerve.
10. Lymphatic glands.

6. THE PLEURA.

The pleura is a serous membrane which invests each lung as far as the root, from whence it is reflected on to the chest walls. The portion covering the lung is called the *pleura pulmonalis* or *visceral layer*, that lining the chest, the *pleura costalis* or *parietal layer*. The portion reflected from the root of the lung forms not only the internal lining of the ribs and intercostal muscles, but is also continued over the diaphragm, and covers the thoracic surface of the vessels at the root of the neck. There the pleura extends for about $1\frac{1}{2}$ to 2 inches above the margin of the first rib, and over it passes, slightly grooving it, the subclavian artery. Extending from the root of the lung by the side of the posterior mediastinum to the diaphragm is a fold of pleura which serves to retain the lower part of the lung in position, and is called the *ligamentum latum pulmonis*, or broad ligament of the lung.

The internal surface of the pleura is smooth, the external, where it is connected with surrounding parts, is rough.

The right pleural cavity is shorter than the left, in consequence of the liver occupying a portion of the right side; the left cavity is longer and narrower, owing to the encroachment of the heart on that side.

The two pleural cavities are separated by a septum formed by the approximation of the two pleuræ reflected from the roots of the lungs. The two pleuræ do not,

however, come in contact, having between them a space which contains all the viscera of the chest, the lungs excepted (see preceding sub-section).

The lower border of the pleura is marked by a line drawn obliquely from the costo-xiphoid articulation to the vertebral end of the twelfth rib.

7. THE PERICARDIUM.

This is a fibro-serous membrane which encloses the heart and part of the great vessels. It is conical in shape, the base being downwards and attached to the central tendon of the diaphragm. The apex is truncated, and surrounds the aorta, pulmonary artery, and superior vena cava, being firmly attached to these vessels a short distance ($1\frac{1}{2}$ inches) from their origin. It invests the great vessels with seven more or less tubular prolongations, as follow:

1. A common one for the aorta and pulmonary artery.
- 2, 3, 4, 5. Four for the pulmonary veins.
6. One for the superior vena cava.
7. A scanty one for the inferior vena cava.

The pericardium has two layers: an external or fibrous, and an internal or serous. The *fibrous* layer is composed of strong interlacing fibres which, after being attached to the great vessels, as above described, become firmly connected to the central tendon of the diaphragm. The *serous* layer consists of a thin stratum of elastic tissue adherent by one surface to the fibrous layer, and smooth on the free surface, giving support to a single or double lamina of tessellated epithelium. The serous layer not only lines the bag of the pericardium, but is reflected on to the heart, which it entirely covers, as well as the great vessels, for a short distance. The portion of serous membrane lining the fibrous layer is called the *parietal* layer, and that covering the heart and great vessels the *visceral* layer. The *arteries* of the pericardium are derived from the thoracic aorta and the internal mammary, its *nerves* from the phrenic, pneumogastric, and sympathetic.

On opening the pericardium from the front, the following structures are seen:

1. Front of right ventricle and apex of the left.
2. Right auricle and its appendix.

3. Appendix of left auricle.
4. Root of pulmonary artery.
5. Part of ascending aorta.
6. Part of superior vena cava.

8. STRUCTURES CONSTITUTING ROOT OF LUNG.

1. Bronchus.
2. Pulmonary artery.
3. Pulmonary veins.
4. Bronchial vessels.
5. Bronchial glands.
6. Anterior and posterior pulmonary nerve plexuses.
7. Connective tissue.

The following are the relations of the pulmonary veins, pulmonary artery, and bronchus on either side :

Both sides.—From before backwards—veins, artery, bronchus.

Right side.—From above downwards—bronchus, artery, veins.

Left side.—From above downwards—artery, bronchus, veins.

9. STRUCTURES IN CONCAVITY OF, AND BEHIND ARCH OF, AORTA.

In concavity :

1. Bifurcation of pulmonary artery.
2. Ligamentous remains of ductus arteriosus.
3. Left bronchus.
4. Left recurrent laryngeal nerve.
5. Superficial cardiac nerve plexus.
6. Large bronchial lymphatic glands.

Behind :

1. Œsophagus.
2. Thoracic duct.
3. Trachea.
4. Left recurrent laryngeal nerve.
5. Deep cardiac nerve plexus.
6. Body of fourth dorsal vertebra.

10. RELATIONS OF TRACHEA IN THE THORAX.

The trachea begins opposite the lower border of the *fifth cervical* vertebra, and ends by bifurcating opposite

the lower border of the *fifth dorsal*. It is about 4 inches long and $\frac{3}{4}$ inch wide. Its relations in the neck have been already described (see p. 20); those in the thorax are as follow :

In front :

1. Manubrium sterni.
2. Remains of thymus.
3. Left innominate vein.
4. The arch of the aorta, with the origins of the innominate and left common carotid arteries.
5. Deep cardiac nerve plexus.

Behind :

1. Œsophagus, with left recurrent laryngeal nerve in the left lateral groove between them.
2. The vertebral column.

Laterally :

1. The pleuræ.
2. The innominate artery (on the right).
3. The left common carotid artery (on the left).
4. The pneumogastric nerves.

The trachea receives blood from the inferior thyroid veins and nerves from the pneumogastrics, recurrent laryngeals, and sympathetic. Its lymphatics pass to the deep cervical and mediastinal glands.

11. THE ŒSOPHAGUS.

The œsophagus commences opposite the fifth cervical vertebra behind the cricoid cartilage, and enters the stomach at the level of the tenth dorsal vertebra. It is ten inches long, and inclines slightly to the left side in both neck and thorax, a fact of surgical importance in relation to the operations of œsophagotomy. Its narrowest part is opposite the cricoid cartilage.*

Its relations may be described in two groups—those in the neck and those in the thorax.

* Also of surgical importance, as it is here foreign bodies are most liable to become impacted and malignant disease to begin.

In the Neck.

In front :

1. Trachea.
2. Left lobe of thyroid body.
3. Left recurrent laryngeal.
4. Inferior thyroid artery.
5. Sterno-mastoid muscle.

Behind :

1. Lowest cervical vertebræ.
2. Longus colli muscle.
3. Prevertebral fascia.

Laterally :

1. Lobes of thyroid gland.
2. Sheath of common carotid artery and its contents.
3. Recurrent laryngeal nerves.

In the Thorax.

In front :

1. Trachea and left bronchus.
2. Left common carotid and subclavian arteries.
3. Arch of aorta.
4. Heart and pericardium.
5. The *plexus gulæ*, formed by the pneumogastric nerves.

Behind :

1. Dorsal vertebræ.
2. Longus colli muscle.
3. Right intercostal arteries.
4. Vena azygos.
5. Thoracic duct.
6. Thoracic aorta (just before passing through diaphragm).

Laterally :

Left : 1. Aorta.

2. Pleura.

Right : 1. Pleura.

2. Vena azygos.

3. Aorta (close by diaphragm).

12. TOPOGRAPHICAL ANATOMY OF THE HEART AND LUNGS.

The Heart.

The heart rests upon the diaphragm.

Its base is opposite the four middle dorsal vertebræ. Its apex is in the fifth intercostal space, being 2 inches below the left nipple, and 1 inch to its sternal side. Its upper limit is indicated by a horizontal line crossing the sternum about the upper border of the third costal cartilages, its right border by a curved line arching from the third right cartilage at the sternum to the seventh right chondro-sternal articulation, reaching about $1\frac{1}{2}$ inches from the middle line. The left border corresponds to an arched line drawn from the apex to the third left cartilage at the sternum.

The Lungs.

The lung apices rise in the neck from one to two inches above the anterior end of the first ribs. The anterior edges of the lung lie behind the sterno-clavicular articulations, then pass obliquely behind the manubrium, and meet in the middle line at its junction with the gladiolus. The edges of the lungs are nowhere in contact. That of the right lung passes vertically downward behind the middle line of the sternum to the sixth chondro-sternal articulation, where it slopes off parallel to the line of the sixth rib. The edge of the left lung goes with the right as far as the fourth chondro-sternal joint, and then follows a line drawn from that point to the apex of the heart.

The lower border of the lung is indicated by a slightly curved line drawn from the sixth chondro-sternal articulation in front to the eleventh dorsal spine posteriorly ; this line touches in the mammary line the sixth, in the mid-axillary line the ninth, and opposite the inferior angle of the scapula the tenth, rib.

It must be remembered that the pleura extends lower down than the lung (see p. 41).

In the *right lung*, the fissure between the upper and lower lobes extends from the spine of the scapula (third rib behind) to the base of the lung in front. The right lung has three lobes, the third being marked off from

the upper by a fissure running upwards and forwards from the fissure between the upper and lower lobes.

In the *left lung* there are only two lobes, and the fissure between them extends from the spine of the scapula (the third rib behind) to the base of the lung in front.

13. CAVITIES OF THE HEART.

The heart contains four chambers, a right and a left auricle, and a right and a left ventricle.

The objects to be noted in each chamber are as follow :

Right Auricle :

1. Surface smooth and even, except in appendix and right wall of sinus venosus,* which are occupied by muscoli pectinati.

2. On posterior wall (*septum auricularum*) are the fossa ovalis, annulus ovalis, openings of the superior and inferior venæ cavæ, tubercle of Lower, and Eustachian valve.

3. On the inferior wall is the auriculo-ventricular opening, between which and the inferior cava is —

4. Opening of the coronary sinus, with the valve of Thebesius.

5. On the anterior wall are the openings of three or four anterior cardiac veins.

6. Foramina Thebesii, variously situated (which are mostly openings of small veins, *venæ Thebesii*).

Left Auricle :

1. Muscoli pectinati in appendix.

2. Openings of pulmonary veins, two on either side of posterior wall.

3. Auriculo-ventricular orifice in lower and fore part.

Right Ventricle :

1. Conus arteriosus (infundibulum) at upper and left angle.

2. Auriculo-ventricular orifice and tricuspid valve.

3. Orifice of pulmonary artery.

4. Columnæ carneæ.

5. Taberculæ.

6. Muscoli papillares.

7. Chordæ tendineæ.

* The *sinus venosus* or *atrium* is that part of the auricle into which the great veins directly pour their blood.

Left Ventricle :

1. Auriculo-ventricular opening with mitral valve.
2. Columnæ carneæ.
3. Trabeculæ.
4. Musculi papillares.
5. Chordæ tendineæ.

14. VEINS OF THE THORAX.

1. *Superior vena cava*, formed by union of right and left innominate veins, which takes place behind first chondro-sternal articulation. It is about three inches long, and opens into the right auricle. It has no valves.

Tributaries :

1. Pericardial.
2. Mediastinal.
3. Vena azygos major.

2. *Innominate veins (brachio-cephalic)* are formed on each side by union of subclavian and internal jugular veins. They unite to form the superior cava. The right vein is about 1 inch long and the more vertical. The left vein is nearly three times as long as the right, and takes a more horizontal course. They have no valves.

Tributaries :

1. Vertebral.
2. Inferior thyroid.
3. Internal mammary.

The left has also :

1. Left superior intercostal.
2. Thymic.
3. Mediastinal.
4. Pericardial.

Opening into the angle of union between the internal jugular and subclavian veins is the thoracic duct on the left, and the right lymphatic duct on the right side.

3. *The inferior vena cava* will be described in Section III. (see p. 70).

4. *The azygos veins*.—The azygos veins are longitudinal vessels resting against the thoracic portion of

the spinal column, and formed by the union of the intercostal veins. They differ on the right and left sides—

(a) *Right or vena azygos major* begins in the abdomen by the *ascending lumbar vein* (which communicates with the common iliac vein). In the thorax it passes in front of the intercostal arteries behind the pleura. At the level of the fifth rib it arches over the root of the right lung, and opens into the superior cava.

Tributaries :

1. Right intercostal veins except that from first space.
2. Right superior intercostal.
3. Left azygos veins.
4. Right bronchial.
5. Œsophageal.
6. Pericardial.
7. Posterior mediastinal.

(b) *Left lower azygos (vena hemiazygos)* begins as left ascending lumbar vein. Passes to level of ninth dorsal vertebra, where it goes behind aorta and opens into vena azygos major.

Tributaries :

1. Lower three or four intercostals.
2. Mediastinal.

(c) *Left upper azygos (vena hemiazygos accessoria)*, formed by union of fourth to seventh or eight intercostal veins, receives also some mediastinal veins and the left bronchial vein, communicates with left superior intercostal, and opens into vena azygos major.

5. *Superior intercostal veins* are formed by the two or three intercostal veins below the first. The *right* enters the vena azygos major, the *left* joins the left innominate.

6. *The first intercostal veins* enter the vertebral vein.

15. LYMPHATIC GLANDS OF THE THORAX.

1. *Sternal glands*, six to ten along internal mammary vessels. *Receive* lymphatics from anterior thoracic and abdominal walls, part of diaphragm and inner part of mamma. *Empty* into anterior mediastinal glands and lymphatic trunks at root of neck.

2. *Intercostal glands*, one to three in each space. *Receive* from thoracic parietes and costal pleura. *Empty* into thoracic duct.

3. *Anterior mediastinal glands*, three or four, behind lower part of body of sternum. *Receive* from lower sternal glands, mesial part of upper surface of liver, and from fore part of diaphragm. *Empty* into right and left lymphatic trunks.

4. *Superior mediastinal or cardiac glands*, large and numerous. In connection with innominate veins and aortic arch. *Receive* from heart, pericardium and thymus. *Empty* into right and left thoracic ducts.

5. *Bronchial glands* numerous, above last group, between bifurcation of trachea. *Receive* from lung. *Empty* into great lymphatic trunks.

NOTE.—It is the bronchial glands which intercept the soot, etc., which enters the lungs. Pale red in infancy, they become gray to black as age advances.

6. *Posterior mediastinal glands*, eight to twelve along descending aorta and œsophagus. *Receive* from œsophagus and hinder part of pericardium and diaphragm. *Empty* into thoracic duct, some into bronchial glands.

16. ARTICULATIONS OF THE THORAX.

The articulations of the thorax may be divided into four groups:—(a) *vertebro-costal*; (b) *costo-chondral*; (c) *chondro-sternal*; and (d) *sternal*.

A.—Vertebro-costal.

These are divided into *costo-central* and *costo-transverse*.

(a) *Costo-central*.—Between heads of ribs and adjacent bodies of two vertebræ (except in the first, eleventh, and twelfth, in which cases with only one vertebra).

Ligaments :

1. *Anterior costo-central or stellate*.—Fibres radiating from head of rib to bodies of vertebræ and intervertebral disc. Fibres between these bundles complete a—

2. *Capsule*.

3. *Interarticular* from ridge separating the two facets on costal head to intervertebral disc. (Absent in the first, eleventh, and twelfth joints.)

Synovial sacs.—Each (except first, eleventh, and twelfth) has two synovial sacs, separated by the interarticular ligament.

(b) *Costo-transverse* between tuberosities of ribs and corresponding vertebral transverse process.

Ligaments :

1. *Posterior costo-transverse* from summit of transverse process to tuberosity of rib.

2. *Middle (interosseous) costo-transverse* unite neck of rib to anterior surface of transverse process.

3. *Superior costo-transverse* are two, anterior and posterior. *Anterior* from neck of rib to transverse process above. *Posterior* from neck of rib to base of transverse process above. (These are wanting in the first rib.)

Synovial sacs.—One to each articulation (except eleventh and twelfth).

B.—Costo-chondral.

The external ends of the cartilages are fixed in oval depressions on ends of ribs, and supported by periosteum.

C.—Chondro-sternal.

These are between inner ends of the cartilages of the sternal ribs and the fossæ in the margins of the sternum. Are all (except the first) synovial joints. They have *capsules* and *anterior* and *posterior* ligaments. In the second articulation there are two synovial sacs divided by an *interarticular* ligament.

D.—Sternal Articulations.

The manubrium and gladiolus are united by a symphysis, with a layer of cartilage (having a fibro-cartilaginous centre) between them. Ligamentous fibres pass between them, being most developed at the back.

Each piece of gladiolus is divided from its fellows by a layer of cartilage, until bony union occurs.

Section III.—THE ABDOMEN AND PELVIS.

1. THE PERINEUM.

THE perineum is a lozenge-shaped space contained within the structures which form the outlet or inferior aperture of the pelvis. In the fresh subject it is bridged across by various muscular structures, certain layers of fascia and the skin. It is of surgical importance from its containing part of the urinary passages and the lower part of the rectum (and vagina in the female), and from the operations thereon (lithotomy, perineal section, fistula, hæmorrhoids, etc.).

Boundaries :

In front.—Symphysis pubis.

Behind.—Coccyx.

Laterally.—Rami of pubes and ischium, glutei maximi muscles, sacro-sciatic ligaments.

A line drawn across from the anterior extremity of one ischial tuberosity to the corresponding point of the other divides the perineum into two parts, an anterior *urethral* and a posterior *anal* portion. This line lies over the transversi perinei muscles.

Muscles—Male :

1. Bulbo-cavernosus (accelerator urinæ).
2. Ischio-cavernosus (erector penis).
3. Transversus perinei (two).
4. Compressor urethræ.
5. Sphincter ani.
6. Levator ani (two).
7. Coccygeus (two).

Female :

1. Bulbo-cavernosus (constrictor vaginæ).
2. Ischio-cavernosus (erector clitoridis).

In dissection the following branches of the *internal pudic artery* are met with :

1. Inferior hæmorrhoidal.
2. Superficial perineal (with the transverse perineal).
3. Artery of the bulb.
4. Artery of corpus cavernosum.
5. Dorsal artery of penis.

Nerves :

1. Inferior pudendal of small sciatic (which communicates with the posterior superficial perineal).

2. Inferior hæmorrhoidal of the pudic (which communicates with the anterior and posterior superficial perineal).

3. Dorsal nerve of penis from the pudic.

4. Perineal nerve of the pudic, dividing into two sets :

(a) *Muscular* to transversus perinei, bulbo-cavernosus and ischio-cavernosus muscles.

(b) *Cutaneous* or *superficial perineal*, of which there are two : — *Anterior* (communicating with inferior hæmorrhoidal and posterior superficial perineal) and *posterior* (communicating with inferior hæmorrhoidal, inferior pudendal and anterior superficial perineal).

5. Fourth sacral nerve.

6. Branches of sciatic nerve.

2. ISCHIO-RECTAL FOSSA.

A deep space between the rectum and ischial tuberosity, containing loose granular fat, perineal and hæmorrhoidal vessels and nerves. It measures some two inches from before back, one inch from side to side, and two to three inches in depth. It is of surgical importance on account of the part it plays in the operations of lithotomy, fistula, etc., and the occurrence of ischio-rectal abscess.

Boundaries :

Externally.—Tuber ischii and fascia over obturator internus muscle.

Internally.—Lower part of rectum, with levator ani muscle covered by the anal fascia.

Anteriorly.—Base of triangular ligament and transversus perinei muscle.

Posteriorly.—Gluteus maximus and coccygeus muscles and great sacro-sciatic ligament.

3. THE TRIANGULAR LIGAMENT.

The triangular ligament is a dense aponeurotic process of fibrous tissue stretched across the pubic arch, triangular in shape, with its apex at the subpubic ligament. Its

depth in the middle line is about $1\frac{1}{2}$ inches. It is formed of two layers, the posterior of which is derived from the *pelvic fascia*. These layers are called *anterior* and *posterior*, but they are more correctly termed *superior* (the posterior) and *inferior* (the anterior); between them are the following structures :

1. Membranous urethra.
2. Compressor urethræ muscles.
3. Cowper's glands.
4. Internal pudic arteries with the following branches :

- (a) Arteries to bulb.
- (b) Arteries to corpus cavernosum.
- (c) Dorsal arteries of penis.

5. Dorsal vein of penis.
6. Dorsal nerves of penis.

The inferior (anterior) layer is pierced by the following :

1. Urethra.
2. Arteries of bulb.
3. Arteries of corpus cavernosum.

In the female the triangular ligament is divided in the middle by the vagina.

Joining the base of the ligament and turning below the transversus perinei muscles is the deep layer of the superficial fascia (*fascia of Colles*), a fact of surgical importance, as extravasated urine is thus directed forwards.

Just behind the triangular ligament is the prostate, with its capsule and plexus of veins. Thus in dissecting down to the prostate from the surface seven layers of alternate fascia and muscle are met with (Cunningham):

1. Superficial fascia.
2. Superficial perineal muscles.
3. Anterior layer of triangular ligament.
4. Compressor urethræ.
5. Posterior layer of triangular ligament.
6. Levator ani muscle.
7. Capsule of prostate.

4. MUSCLES OF THE ABDOMINAL WALL.

The muscles forming the front, back and sides of the abdominal wall are as follows :

1. *External oblique*.—Fibres directed downwards and inwards. *Arises* from outer surface of lower eight ribs by digitations (lower four or five interdigitate with serratus magnus, upper three or four with latissimus dorsi). *Inserted* into anterior half of external lip of ilium and into the aponeurosis, meeting its fellow of the opposite side at the *linea alba*, forming part of the sheath of the rectus abdominis muscle. The upper fibres of aponeurosis are connected with the pectoralis major, the lower fibres stretch across from anterior superior iliac spine to pubic spine as *Poupart's ligament*.* Between the origins of the external oblique and the latissimus dorsi at the iliac crest is a small triangular interval, the *triangle of Petit*, through which a *lumbar hernia* may protrude.

2. *Internal oblique*.—Fibres directed upwards and inwards. *Arises* from external half or two-thirds of deep surface of Poupart's ligament, from the two-thirds of middle lip of iliac crest and from lumbar fascia. *Inserted* into cartilages of lower three ribs, aponeurosis of internal oblique, and the lowest fibres arch across the spermatic cord or round ligament (in the female), join the transversalis muscle, and are attached to front of pubis and inner part of ilio-pectineal line (behind Gimbernat's ligament) as the *conjoined tendon*.

The aponeurosis is attached above to the ensiform cartilage and seventh and eighth costal cartilages. At the margin of the rectus muscle it splits into two layers, one going anterior (this layer is inseparably connected with the aponeurosis of external oblique), and one posterior to that muscle ; they reunite at the *linea alba* so as to enclose the rectus in a sheath. The line at which the aponeurosis splits is called the *linea semilunaris*. The division into two layers stops midway between umbilicus and pubis, the whole aponeurosis for that space going in front of the rectus. The free edge of

* For Gimbernat's ligament, external abdominal ring, etc., see p. 56.

the posterior layer is called the *semilunar fold of Douglas*. During the descent of the testicle, some of the fibres of the external oblique are pushed down before that gland into the scrotum, forming the *cremaster muscle*. This muscle is attached externally to Poupart's ligament, and internally to spine and crest of pubis.

3. *Transversalis*.—Fibres are horizontal. *Arises* from cartilages of lower six ribs (interdigitating with diaphragm), from transverse process of lumbar vertebræ, from anterior two-thirds of inner margin of iliac crest, and from outer one-third of Poupart's ligament. *Inserted* into aponeurosis and conjoined tendon. The anterior aponeurosis of transversalis united to that of internal oblique, in its upper two-thirds to the posterior layer (forming posterior wall of rectus-sheath) and for its lower one-third passing in front of rectus. The posterior aponeurosis forms the *lumbar fascia* (see p. 77).

Between the internal oblique and transversalis muscles are the lower intercostal nerves and a branch of circumflex iliac artery.

4. *Rectus abdominis*.—Fibres vertical. *Arises* from pubis by flat tendon, consisting of two parts. Internal (smaller) connected to ligaments covering front of symphysis pubis, external attached to pubic crest. The rectus is contained in a sheath chiefly formed, as above described, by the aponeurosis of internal oblique, and is *inserted* into cartilages of fifth, sixth, and seventh ribs, and into ensiform cartilage. In it are three or four irregular tendinous intersections, called *inscriptiones tendineæ*. Of these, three are constant, and are placed: one opposite umbilicus, one at lower end of ensiform cartilage, and one intermediate between them.*

5. *Pyramidalis*.—Varies greatly, and is often absent on one or both sides. *Arises* from front of pubis below rectus, inserted into linea alba.

6. *Quadratus lumborum*.—Is placed between last rib and pelvis, close to vertebral column. *Arises* from ilio-lumbar ligament, about two inches of iliac crest, and transverse processes of two, three, or four lumbar vertebræ. Inserted into last rib and transverse pro-

* The following muscles have tendinous intersections besides the rectus abdominis: Occipito-frontalis, digastric, omo-hyoid, trachelo-mastoid, complexus, semi-tendinosus, and soleus.

cesses of upper four lumbar vertebræ (behind slips of origin). It is enclosed in a sheath formed of anterior and middle layers of lumbar fascia (see p. 77).

Nerves.—The abdominal muscles are supplied generally by the lower intercostal nerves. Internal oblique and transversalis by ilio-hypogastric and ilio-inguinal in addition. Cremaster by genital branch of genito-crural. Quadratus lumborum by branches of last dorsal and upper lumbar.

5. THE INGUINAL CANAL AND COVERINGS OF INGUINAL HERNIA.

The inguinal canal commences at the internal abdominal ring, and terminates at the external abdominal ring, its length being about one inch and a half. It serves for the passage of the *spermatic cord* in the male, and the *round ligament* with its vessels in the female. Its boundaries are :

In front.—Skin, superficial and deep fasciæ, aponeurosis of external oblique for whole length, internal oblique for outer third.

Behind.—Conjoined tendon for inner two-thirds, fascia transversalis, subperitoneal fat and peritoneum for whole length.

Above.—Arched border of transversalis muscle.

Below.—Poupart's ligament.

External abdominal ring.—A triangular opening in aponeurosis of external oblique muscle, through which spermatic cord reaches surface of body. Placed near crest of pubis internal to pubic spine. Its apex points upwards and outwards. Its margins are called *pillars*. The *internal pillar* is thin and straight, the *external* one is curved, continuous with Poupart's ligament, and forms a groove in which rests the spermatic cord. Passing across the ring are the *intercolumnar fibres*, which are prolonged onto the cord as the *intercolumnar fascia*.

Internal abdominal ring.—The oval aperture by which the spermatic cord leaves the abdominal cavity. It is situated midway between the symphysis pubis and the anterior superior iliac spine, half an inch above Poupart's ligament. Into it a finger-like protrusion of the trans-

versalis fascia passes round the spermatic cord, forming the *infundibuliform fascia*.

The inguinal canal is of surgical importance as the channel through which an inguinal hernia escapes from the abdomen. Inguinal herniæ are of two kinds, *oblique* and *direct*. The former enters the inguinal canal through the internal abdominal ring, passes obliquely along the canal and through the external ring to descend into the scrotum.

Direct.—Inguinal hernia escapes from the abdomen at Hesselbach's triangle. (See No. 6 of this section, below), and passes through the external ring.

The following are the coverings of each variety of hernia, commencing at the surface :

Oblique :

1. Skin and superficial fascia.
2. Intercolumnar fascia.
3. Cremaster muscle and fascia.
4. Infundibuliform fascia.
5. Subperitoneal fat.
6. Peritoneum.

Direct :

1. Skin and superficial fascia.
2. Intercolumnar fascia.
3. Conjoined tendon (unless the hernia perforates that structure).
4. Fascia transversalis.
5. Subperitoneal fat.
6. Peritoneum.

6. HESSELBACH'S TRIANGLE.

The space which is known as the triangle of Hesselbach is situated at the lower part of the abdominal wall on either side, and is of surgical importance as the spot where direct inguinal hernia makes its escape from the abdomen. Its boundaries are :

Externally.—Epigastric artery.
Internally.—Outer margin of rectus abdominis muscle.
Base.—Poupart's ligament.
 The structures entering into the formation of the abdominal wall at this spot are (from without inwards) :

1. Skin, superficial and deep fasciæ.
2. Aponeurosis of external oblique muscle with external abdominal ring and intercolumnar fascia.
3. Conjoined tendon.
4. Fascia transversalis.
5. Subperitoneal fat.
6. Peritoneum.

The triangle is subdivided by the *obliterated hypogastric artery* into two *inguinal fossettes*, through either of which a direct hernia may protrude.

7. THE SPERMATIC CORD.

The spermatic cord commences at the internal abdominal ring, passes obliquely along the inguinal canal, escapes at the external abdominal ring, descends into the scrotum, and terminates at the posterior border of the testicle. The structures entering into the composition of the cord are :

1. The investing tunics or coverings of the cord, viz. :
 + { (a) intercolumnar or external spermatic fascia ;
 (b) cremaster muscle and fascia ; (c) external spermatic or infundibuliform fascia.
2. The vas deferens.
3. Spermatic artery (from abdominal aorta).
4. Deferential artery (from superior vesical).
5. Cremasteric artery (from deep epigastric).
6. Spermatic veins (forming *pampiniform plexus*).
7. Lymphatic vessels (large and numerous).
8. Spermatic nerve plexus (from aortic and renal sympathetic plexuses).
9. Genital branch of genito-crural nerve.
10. Scrotal branch of ilio-inguinal nerve.

8. THE ABDOMINAL CAVITY.

The abdominal cavity proper is the space included between the spinal column behind, the abdominal muscles in front and at the sides, roofed in by the diaphragm above, and reaching to the brim of the pelvis below ; below is the cavity of the pelvis. The abdominal cavity contains the alimentary tube and its accessories,

the kidneys with their ureters, and the supra-renal bodies.

Regions.—The abdominal cavity is marked off by the following imaginary lines into nine regions.

1. A circular line round the body at the level of the ninth rib cartilage.

2. A circular line round the body at the level of the most prominent part of the iliac crest.

3 and 4. Two vertical lines from the cartilage of the eighth rib to the centre of Poupart's ligament on either side.

By the intersection of these lines are formed the following regions, here given in their proper positions :

Right hypochondriac, epigastric, left hypochondriac.

Right lumbar, umbilical, left lumbar.

Right iliac, hypogastric, left iliac.

On first opening the abdomen the following structures are seen :—Part of liver, part of stomach, large omentum (concealing small intestine), part of large intestine, and part of bladder (if distended).

The viscera contained in each of the above regions are liable to variation, but the following may be taken as forming the contents of each :

Right hypochondriac.—Liver and gall bladder, pyloric end of stomach and duodenum, hepatic flexure of colon, upper part of right kidney, supra-renal capsule and pancreas.

NOTE.—The fundus of the gall-bladder is behind the right ninth costal cartilage.

Epigastric.—Part of liver and stomach, transverse colon, great omentum, pancreas, large abdominal vessels and some of their branches, solar plexus.

Left hypochondriac.—Cardiac end of stomach, tail of pancreas, spleen, splenic flexure of colon, upper end of left kidney, and supra-renal capsule.

Right lumbar.—Ascending colon, descending duodenum, kidney, ureter. coils of small intestine.

Umbilical.—Part of transverse colon and duodenum, great omentum, small intestine, bifurcation of aorta.

Left lumbar.—Descending colon, kidney, ureter, small intestine.

Right inguinal.—Cæcum, vermiform appendix, small intestine, ureter, spermatic vessels.

Hypogastric. — Omentum, rectum, small intestine, fundus of child's bladder, and that of distended adult's bladder.

Left inguinal. — Sigmoid flexure of colon, small intestine, ureter, spermatic vessels.

9. THE PERITONEUM

The peritoneum is a serous membrane lining the abdominal cavity, and reflected on to most of the contents thereof. It is the largest serous membrane in the body. It is a closed sac in the male, but in the female is continuous with the canals of the Fallopian tubes.

In order to understand the continuity of the peritoneum it must be traced in both the horizontal and vertical directions.

(a) *Horizontal circle around abdomen at level of umbilicus.*—Starting from the umbilicus, it lines the abdominal wall (*parietal layer of peritoneum*) to the large intestine on the left side, over which it goes, fixing it to the wall. From the colon it passes over the left kidney to the middle line, where it is reflected along the vessels supplying the small intestine, round the latter and back to the spine along the same vessels, forming the *mesentery* of the small intestine. It then goes outwards over the right kidney to the colon, which it fixes as on the left side, and so along the abdominal wall to the umbilicus.

Occasionally the ascending or descending colon, or both, are invested like the small intestine, and are said to possess a *meso-colon*. This variation occurs in 48 per cent. of all cases, on the left side in 36 per cent., and on the right in 26 per cent. (Trevez). This variation is of surgical importance in the operation of lumbar colotomy.

Similarly the kidney may possess a *meso-nephron*, of surgical importance as accounting for the condition known as floating kidney.

(b) *Vertical circle from above downwards.* — Starting again from the umbilicus the peritoneum passes upwards, lining the abdominal wall and under part of the diaphragm as far as the posterior part of the upper surface of the

liver ; reflected on to that organ, it goes to its under surface as far as its transverse fissure, where it passes along the hepatic vessels (forming *anterior layer of small omentum*) to the upper border of the stomach. It then passes over the anterior gastric surface, and at its lower border passes down to form the foremost layer of the *great omentum* ; at the lower part of the abdomen it returns, forming the hindmost layer of the great omentum to the transverse colon, which it partially invests ; leaving that viscus posteriorly where its vessels enter, it goes along the posterior surface to the spine, forming the posterior layer of the *transverse meso-colon*. On reaching the spine it goes downwards over the anterior surface of the duodenum, fixing it, and then is reflected along the vessels of the small intestine, round the small bowel to the spine again (forming *mesentery of small intestine*). It then passes down into the pelvis, partially investing the rectum and bladder (forming between them the *recto-vesical pouch*), on to the abdominal wall and so back to the umbilicus. In the female, the *recto-vaginal pouch* (*pouch of Douglas*) and *utero-vesical pouch* are similarly formed.

The part of peritoneum above described is known as its *great bag* ; its *small bag* (with which the former communicates by the *foramen of Winslow*) will now be described.

Starting from the transverse hepatic fissure, the peritoneum passes behind the hepatic vessels (forming posterior layer of *small omentum*) to the upper border of the stomach. Investing the posterior surface of the stomach, it passes at its lower border into the *great omentum*, then covers the upper and anterior surface of the transverse colon, leaving it as the upper layer of the *transverse meso-colon*. Arrived at the spine it passes upwards over the pancreas (and fixes it) to the liver, the under surface of which it invests as far as the transverse fissure, from whence the description started.

In order to properly understand the *foramen of Winslow*, the peritoneum must be followed horizontally at the level of that foramen. Commencing in the middle line of the abdomen, the membrane lines the anterior wall, and on the right side invests the obliterated umbilical vein (round ligament of liver), thus forming the hepatic

falciform ligament. Passing onwards, it is reflected over the right kidney, across the aorta and vena cava, and over the left kidney to the hilum of the spleen (anterior layer of *lienorenal ligament*). Thence it is reflected onto the posterior wall of the stomach, passes round the hepatic vessels, forming the *lesser omentum* from stomach to transverse fissure of liver. It then covers the front of the stomach, and, on arriving at the cardiac end, it passes to the spleen, which it encloses, forming the *gastro-splenic omentum*. From the spleen it passes back to the abdominal wall (forming the posterior layer of the *lienorenal ligament*), and so to the middle line of the abdomen again.

The *foramen of Winslow* is bounded thus :

In front. — Lesser omentum, enclosing vena portæ, hepatic artery and duct.

Behind. — Inferior vena cava.

Above. — Lobus Spigelii and lobus caudatus.

Below. — Hepatic artery as it curves forwards from the celiac axis.

10. VISCERA INVESTED BY PERITONEUM.

(a) *Almost entirely invested :*

Liver.

Stomach.

Spleen.

First part of duodenum.

Jejunum.

Ileum.

Transverse colon.

Sigmoid flexure of colon.

First part of rectum.

Uterus and ovaries (in the female).

(b) *Partially invested :*

Second and third parts of duodenum.

Cæcum.

Ascending colon.

Descending colon.

Middle part of rectum.

Posterior surface of bladder.

Upper part of posterior wall of vagina (in the female).

(c) *Covered but not invested :*

Kidneys.

Supra-renal capsules.

Pancreas.

11. THE LOBES AND FISSURES OF THE LIVER.

Lobes.—The liver has *five* lobes. It is divided primarily into two :

1. Right lobe.

2. Left lobe.

Occupying the right lobe are three others :

3. Quadrate lobe.

4. Spigelian lobe.

5. Caudate lobe.

Fissures.—The liver has *five* fissures :

1. Transverse or portal. (Between quadrate lobe in front and Spigelian and caudate lobes behind.)

2. Longitudinal (between right and left lobes).

3. Vena caval (on right of Spigelian lobe).

4. Fissure of ductus venosus (between Spigelian and caudate lobes).

5. Fissure of round ligament (between left and quadrate lobes).

The structures entering the transverse fissure are also *five* in number :

1. Hepatic artery (from coeliac axis).

2. Portal vein.

3. Hepatic duct.

4. Lymphatics.

5. Nerves (from sympathetic and pneumogastric).

The relations of the vessels entering the transverse fissure are as follow (from before back) :

1. Hepatic duct.

2. Hepatic artery.

3. Portal vein.

The ligaments of the liver are again *five* in number :

1. Suspensory or falciform (formed by peritoneum).

2. Round (obliterated umbilical vein).

3. Coronary (formed by peritoneum).

4 and 5. Right and left lateral (formed by peritoneum).

12. THE DIAPHRAGM.

The diaphragm is an arched muscle which forms a musculo-tendinous partition between the thorax and abdomen. It consists of fleshy fibres which, arising at the circumference of the abdomino-thoracic cavity, are inserted into a central tendon.

The *origin* of the diaphragm is divided into the following parts :

1. *Vertebral*.—Arising by two *crura* and two *arched ligaments*. The *crura* arise from the upper three of four lumbar vertebral bodies and their intervertebral discs on the right, and from the first and second lumbar vertebræ on the left side. These processes form an arch over the front of the aorta. The *ligamentum arcuatum internum* and *externum* are fibrous bands, the former arching over the psoas (attached to body and transverse process of first lumbar vertebra), the latter over the quadratus lumborum (attached to transverse process of first lumbar vertebra and last rib). From these ligaments arise muscular fibres.

2. *Costal*.—Fleshy serrations from cartilages of six lower ribs (interdigitating with the transversalis abdominis).

3. *Sternal*.—This is a short slip from the back of the ensiform cartilage.

The *insertion* of these fibres is into the *central, trefoil, or cordiform tendon*, which is a strong aponeurosis having three *alæ*, of which the right is the largest and the left the smallest.

Foramina.—These are *three* large openings in the diaphragm :

1. Aortic (*hiatus aorticus*) for passage of aorta, thoracic duct, and vena azygos major.
2. Œsophageal, for Œsophagus, pneumogastric nerves and Œsophageal branches of coronary artery.
3. Caval (*foramen quadratum*) for vena cava inferior.

There are also the following smaller orifices :

4. One in each crus for splanchnic nerves.
5. One in left crus for small azygos vein.
6. Sometimes one in each crus for sympathetic nerves.

Relations.—In the dead subject the diaphragm rises on the right to a level with the junction of the fifth rib and its cartilage, on the left side only to that of the sixth rib and cartilage. This is due to the presence of the liver on the right side.

Above.—Pleura, lungs, and heart, and the fibrous layer of the pericardium, which blends with the central tendon. (See Section II., p. 41.)

Beneath.—Peritoneum, liver, stomach, pancreas, spleen, kidneys, and suprarenal bodies.

Nerve supply.—Phrenic nerves (which pierce the muscle and supply its under surface), lower intercostals, and filaments from sympathetic plexuses on phrenic branches of abdominal aorta.

Blood supply.—Comites nervorum phrenici (*superior phrenics*) from internal mammary. Musculo-phrenics (*middle phrenics*) from internal mammary. Phrenics (*inferior phrenics*) from abdominal aorta. Also twigs from intercostal arteries.

13. BOUNDARIES OF THE PELVIS.

The cavity of the pelvis is surrounded with the bony ring of pelvic bones, its boundaries being as follows :

In front and at sides.—Innominate bones covered by the obturator muscles.

Behind.—Sacrum, coccyx, pyriformis muscles and sacro-sciatic ligaments.

It contains the bladder, the lower end of the rectum, some of the generative organs (according to the sex), with peritoneum, etc.

The *floor* of the pelvis is formed by the following structures on either side from behind forwards :

1. Pyriformis muscle.
2. Sacro-sciatic ligaments.
3. Coccygeus muscle.
4. Levator ani muscle.
5. Triangular ligament.

14. STRUCTURES PASSING THROUGH INLET OF PELVIS.

(a) *Viscera and ducts :*

1. Rectum.
2. Coils of small intestine (generally).

3. Ureters.
4. Vasa deferentia (in male), round ligaments (in female).
5. Urachus and obliterated hypogastric arteries.
6. Bladder (in child, or in adult if distended).
7. Uterus (in female, if pregnant).

(b) *Vessels* :

1. Internal iliac.
2. Superior hæmorrhoidal.
3. Branches of vasa intestini tenuis.
4. Sacra media.
5. Ilio-lumbar.
6. Spermatic (in male), ovarian (in female).
7. Obturator (when arising abnormally from deep epigastric).
8. Pubic branches of deep epigastrics.
9. Veins corresponding to the above arteries.
10. Lymphatic vessels.

(c) *Nerves* :

1. Lumbo-sacral cord.
2. Obturator.
3. Sympathetic.
4. Branches from hypogastric plexus.

In addition to the above, the peritoneum investing the various viscera and the fasciæ from the abdominal parietes, which become pelvic, should be enumerated among the structures passing through the inlet of the pelvis.

15. THE PELVIC FASCIA.

The walls and floor of the pelvis are lined by a fascia, the *pelvic fascia*. This fascia is divided into two distinct parts, *parietal* and *visceral*.

(a) *Parietal layer*.—Begins at brim of true pelvis, to which it is attached. Thence it passes along pelvic wall, lining it and covering the obturator internus muscle (*obturator fascia*). Below it is attached to the pubic and ischial rami and to the ischial tuberosity. Behind it covers the pyriformis muscle.

(b) *Visceral layer*.—This comes off from the parietal

layer, along a line running from the lower part of the symphysis pubis to the ischial spine, the *white line*, which corresponds to the origin of the levator ani. From this line the visceral layer passes down along the abdominal side of the levator ani, and becomes attached to all the pelvic viscera, with which it comes in contact, furnishing them with coverings, and fixing them in place by fibrous expansions or 'ligaments.' This layer is called the *recto-vesical fascia*.

All that part of the fascia above the 'white line' is in the pelvic cavity, that below being in the perineum. The lower segment is called the *obturator fascia*.

The *recto-vesical fascia* has the following arrangement in connection with the viscera in the pelvic cavity:—Anteriorly, where it meets the side of the bladder, along the line of its junction with the prostate gland, it divides into two layers; the upper one is reflected upwards, and becomes closely united with the vesical muscular coat; the lower one is continued over the prostate, forming its sheath, and at the apex of that gland goes to the back of the pubes, forming the *superior (posterior) layer of the triangular ligament* (see No. 3 of this section, p. 52). Behind and above the prostate the prolongation of the upper layer is attached to the base of the bladder outside the line of the vesiculæ seminales (thus excluding them from the proper pelvic cavity). The inferior layer (continuous with posterior part of sheath of prostate) extends between the bladder and rectum, forming the front part of the sheath of the latter viscus. In the female the vagina receives an investment from the recto-vesical fascia, which corresponds to the prostatic sheath in the male.

16. RELATIONS OF THE PROSTATE GLAND.

Above.—Bladder, with its anterior true ligaments, dorsal vein of penis.

In front.—Symphysis pubis, triangular ligament, sub-pubic ligament.

Behind.—Rectum (at bend between second and third parts).

Behind and above.—Recto-vesical pouch of peritoneum.

Behind and below.—Third part of rectum, vesiculæ seminales, vasa deferentia.

Below.—Central point of perineum, perineal raphé.

Below and in front.—Triangular ligament, membranous urethra, bulb of urethra.

Laterally.—Anterior fibres of levator ani muscle (*levator prostatae*), recto-vesical fascia, prostatic venous plexus.

17. THE URETHRA.

The urethra differs greatly in the two sexes. The male tube measures in the adult, from the neck of the bladder to the meatus urinarius, about nine inches, in the female only an inch and a half.

The male urethra:

The male urethra is named according to its structure and the parts it traverses, as follows:

(a) *Prostatic.*—An inch and a half.

(b) *Membranous.*—Half an inch. Between two layers of triangular ligament.

(c) *Penile or spongy.*—Remaining seven inches. Of this the part contained in the bulb is often called the *bulbous portion*.

The prostatic portion lies near the upper portion of the gland, the involuntary muscular tissue of which surrounds it as a sphincter. It is wide and dilatable. Along the floor is a ridge, the *veru montanum*, under which is a tunnel, the *sinus pocularis*, or *utriculus masculinus* (homologue of uterus). On either side of the *veru montanum* is a groove, the *prostatic sinus*, into which open some dozen follicular glands. At the margins of the *sinus pocularis* open the *common ejaculatory ducts*.

The membranous portion lies about an inch below the symphysis. It is surrounded by a thin erectile layer, then some involuntary muscular fibres, and externally by the compressor urethræ muscle.

The spongy portion is very capacious in its bulbous part, into which open the ducts of *Cowper's glands*. In that part between this and the glans penis open many small follicular glands (*glands of Littre*). The part contained in the glans is dilated (*fossa navicularis*), in its roof opens the largest of Littre's follicles, the *lacuna*

magna. The meatus urinarius is the narrowest part of the canal.

The female urethra.—The female urethra runs downwards and forwards, parallel with the vagina, and embedded in its anterior wall. The narrowest part is the meatus, which opens on a small papilla in the vestibule. The female urethra is very dilatable, and corresponds to the prostatic portion of the male tube.

18. STRUCTURES CONTAINED IN THE BROAD LIGAMENTS.

The broad ligaments of the uterus contain the following structures on either side :

1. The Fallopian tube.
2. The round ligament.
3. The ovary.
4. The parovarium.
5. The uterine and ovarian vessels.
6. The pampiniform plexus of veins.
7. Lymphatics.
8. Nerves.
9. Connective tissue, with some unstriated muscular fibres.

19. VEINS OF THE ABDOMEN AND PELVIS.

The portal system.—The portal vein differs from other veins in being subdivided into branches at both extremities. It is formed by the *superior and inferior mesenteric and splenic veins*. These branches receive the following tributaries :

1. *Superior mesenteric*.—Branches corresponding with superior mesenteric artery, and right gastro-epiploic vein.
2. *Inferior mesenteric*. — Branches of corresponding artery.
3. *Splenic*.—Branches (five or six) form spleen, gastric, left gastro-epiploic, and pancreatic. Sometimes also inferior mesenteric and coronary.

The portal vein is joined by the *pyloric and coronary* veins.

Entering the transverse fissure of the liver, the portal

vein divides into right and left branches ; these break up into ramifications, and converge to the groove in the liver in which the inferior vena cava lies, opening into three or four hepatic veins.

The inferior vena cava returns the blood from the pelvis, abdomen, and lower extremities. It begins opposite the fifth lumbar vertebræ by the union of the common iliac veins, and ends by perforating the diaphragm and opening into the right auricle (see p. 46). Besides the common iliacs, it receives the following tributaries :

1. Lumbar, corresponding to lumbar arteries.
2. Right spermatic (in male), ovarian (in female).
The left spermatic joins the renal vein.
3. Renal.
4. Supra-renal.
5. Hepatic.
6. Inferior phrenic.

The common iliac veins.—These are formed by the union of the external and internal iliac veins, which takes place opposite the base of the sacrum. They receive the ilio-lumbar and middle sacral veins.

The internal iliac veins are formed by the union of branches which mostly accompany the internal iliac artery. The exceptions to these are the following :

1. Ilio-lumbar, which open into the common iliac.
2. Pudic veins, which do not receive any blood from the dorsal vein of the penis.

The pelvic veins form a series of plexuses, the prostatic, vesical, hæmorrhoidal, vaginal, and uterine.

The prostatic plexus is mainly formed by the breaking up of the dorsal vein of the penis ; it receives branches from the gland and the neighbouring muscles.

The vesical plexus ramifies over all the bladder external to the muscular coat, receiving branches from the ureters, vasa deferentia, and vesiculæ seminales, and communicating with the prostatic and hæmorrhoidal plexuses in the male, and the uterine and vaginal in the female.

The hæmorrhoidal plexus surrounds the lower part of the rectum immediately beneath the mucous membrane. From it *superior, middle, and inferior hæmorrhoidal*

veins go to the inferior mesenteric vein, and so to the portal system.

NOTE.—The surgical importance of the last-named plexus as being that involved in the formation of hæmorrhoids, or piles, is of great moment.

20. LYMPHATIC GLANDS OF THE ABDOMEN AND PELVIS.

1. *External iliac glands*.—Three to five along external iliac vessels, the largest just above Poupart's ligament. *Receive* lymphatics from inguinal glands and abdominal wall, and *empty* into lumbar glands.

2. *Internal iliac glands*.—Numerous. Along internal iliac vessels; these, with the

3. *Sacral glands* in the hollow of the sacrum, *receive* from pelvic viscera and parietes.

4. *Lumbar glands*.—Large, numerous, and placed in three groups, a median and two lateral. The *median* lie on the common iliac vessels, aorta, and vena cava. *Receive* from external and internal iliac, lateral lumbar, and sacral glands, from kidneys, supra-renal bodies, testes (ovaries and part of uterus in female), and vertebral part of diaphragm. The *lateral* groups are smaller, lie behind psoas muscle in intervals between transverse process of vertebræ, and *receive* from hinder part of abdominal wall. The lumbar glands empty (in great part by the *lumbar lymphatic trunk*) into the thoracic duct.

5. *Mesenteric glands*.—From 130 to 150, or more. Lie in the mesentery around vessels and trunk of superior mesenteric artery. Some are called *ileo-colic* (between ileum and ascending colon), some are *meso-colic*. They *receive* the *lacteals* from the intestine, join the efferent trunks of the cœliac glands, and enter the thoracic duct by the *intestinal lymphatic trunk*. Those from the colon and sigmoid flexure join the lumbar lymphatics.

6. *Cœliac glands*.—Sixteen to twenty large glands, surrounding cœliac axis. *Receive* from stomach, spleen, pancreas, and greater part of liver. *Empty* into thoracic duct.

The thoracic duct.—From 15 to 18 inches long. Extends from second or third lumbar vertebra to the root of the

neck. At its lower part it has a dilatation (*receptaculum chyli*). Its upper extremity arches over the left lung and pleura, and opens into the angle between the internal jugular and subclavian veins.

21. ARTICULATIONS OF THE PELVIS.

A.—Pelvis with Fifth Lumbar Vertebra.

The fifth lumbar is united with the first sacral vertebra by anterior and posterior body ligaments, capsular of articular processes, ligamenta subflava, inter- and supraspinous ligaments, and an intervertebral disc. For a description thereof see Section IV. (p. 79). It is also attached to the pelvis by two other ligaments :

(a) *Lateral lumbo-sacral*.—From lower border of last lumbar transverse process to lateral part of base of sacrum.

(b) *Ilio-lumbar*.—Passes outwards and backwards from summit of last lumbar transverse process to iliac crest.

B.—Articulations of Sacrum and Coccyx and of Coccyx.

The sacrum and coccyx are joined by an *intervertebral disc*, *anterior*, *posterior*, *interarticular*, and *lateral ligaments*. While the pieces of the coccyx are separate, they are articulated by fibro-cartilaginous discs and anterior and posterior ligaments.

C.—Sacro-iliac Articulation.

Between the auricular surfaces of the sacrum and ilium, which are covered by a layer of cartilage.

Ligaments :

1. *Anterior sacro-iliac*.—From sacrum to ilium on their iliac and pelvic surfaces.

2. *Posterior sacro-iliac*.—From the rough space above the auricular surface of ilium downwards and backwards to depressions on back of lateral mass of sacrum. A superficial band from posterior superior iliac spine to third and fourth pieces of sacrum is called the *long* or *oblique sacro-iliac ligament*.

D.—Sacro-sciatic Ligaments.

(a) *Posterior or great sacro-sciatic ligament*.—Broad and triangular, assists in bounding outlet of pelvis. Base attached to posterior inferior iliac spine, and sides of sacrum and coccyx. Apex fixed to inner margin of ischial tuberosity, sending a *falciform process* along margin of ischial ramus, which forms inferior attachment of obturator fascia.

(b) *Anterior or small sacro-sciatic ligament*.—Triangular in form. Base attached to sides of sacrum and coccyx, apex to ischial spine.

Foramina.—Between the sacro-sciatic ligaments and the hip-bone is a large space subdivided by the small ligament into *great* and *small sacro-sciatic foramina*. The former transmits the following structures :

1. Piriformis muscle.
2. Gluteal, sciatic, and pudic vessels and nerves.
3. Nerves to obturator internus and quadratus femoris muscles.

The lesser sacro-sciatic foramen transmits :

1. Obturator internus muscle.
2. Pudic vessels and nerve.
3. Nerve to obturator internus muscle.

E.—Pubic Articulation.

The articulation of the symphysis pubis is effected by an interpubic disc and ligaments.

The interpubic disc consists of a layer of cartilage on either side, with fibrous tissue and fibro-cartilage between. A fissure in its centre is formed by the softening and absorption of the fibro-cartilage, and is not usually found before the seventh year. It is much more developed in the female.

Ligaments :

(a) *Anterior pubic*.—Thick, consisting of transverse and obliquely interlacing fibres, chiefly derived from the rectus and obliquus externus muscles of the abdomen.

(b) *Superior*.

(c) *Posterior*.—These consist of a few fibres each.

(d) *Inferior*, or *Subpubic*, is thick and triangular, and attached to the inferior pubic rami.

F.—Obturator Membrane.

A fibrous stratum attached to the borders of the obturator foramen and closing it, except for a small aperture (*obturator canal*) at the obturator groove above, which serves for the passage of the obturator vessels and nerve. The obturator muscles (external and internal) are attached to the surfaces of the obturator membrane.

Section IV.—THE BACK.

1. TOPOGRAPHICAL ANATOMY OF THE BACK.

The back may be divided into a *median* and two *lateral* portions.

(a) In the *median* line the spines of the upper cervical vertebræ can just be felt. They lie in a furrow; that of the axis can be best made out in its situation at the nape of the neck. At the base of the neck the spinous process of the seventh cervical vertebra can be seen and easily felt (*vertebra prominens*). The first two dorsal spines are prominent and evident to the touch. The remaining spines, dorsal and lumbar, lie in the *spinal furrow*, the groove formed by the prominence of the back muscles on either side. The spinal cord ends opposite the second lumbar vertebra.

On either side of the spinal furrow are the large and prominent masses of the erector spinæ muscles.

(b) The *lateral* parts present above the scapulæ. The root of the spine of the blade-bone is opposite the third dorsal spinous process; its inferior angle is on a level with that of the seventh dorsal, and the whole bone covers the ribs from the second to the seventh inclusive (sometimes the eighth). The outline of the trapezius muscle is readily recognisable, its lower border being level with a line drawn from the spine of the scapula to the last dorsal spinous process.

Lower down the latissimi dorsi muscles can be made out on either side. Their upper borders correspond to a

line drawn horizontally from the sixth dorsal spine, over the inferior angle of the scapula. The top of the iliac crests are prominent, and opposite to the fourth lumbar spine. In the lumbar region the masses of the erectores spinæ are most marked and thick.

The spines of most of the dorsal vertebræ do not tally with the heads of their corresponding ribs, that of the second corresponding with the head of the third rib, and so on. The spines of the eleventh and twelfth dorsal vertebræ are exceptions to this rule.

2. MUSCLES OF THE BACK.

The muscles of the back are divisible into five layers. In this description the attachments of the first three layers only will be given.

First Layer.

Two muscles, trapezius and latissimus dorsi :

1. *Trapezius*. — *Arises* from spines of all dorsal vertebræ and supra-spinous ligament, spine of seventh cervical vertebra, ligamentum nuchæ, and inner third of superior curved line of occipital bone. *Inserted* into outer third of posterior aspect of clavicle, posterior border of acromion and upper edge of scapula (as far as an inch from its root).

2. *Latissimus dorsi*. — *Arises* from spines of six lower dorsal, all the lumbar and upper two sacral vertebræ, supra-spinous ligament, outer edge of posterior half of iliac crest, and three or four lower ribs (interdigitating with external oblique of abdomen). *Inserted* into bottom of bicipital groove of humerus.

Second Layer.

Three muscles, levator anguli scapulæ, rhomboideus major and minor :

1. *Levator anguli scapulæ*. — *Arises* from posterior transverse processes of upper three or four cervical vertebræ. *Inserted* into base of scapula, between spine and superior angle.

2. *Rhomboideus minor*. — *Arises* from spines of seventh cervical and first dorsal vertebræ, and ligamentum

nuchæ. *Inserted* into base of scapula opposite root of spine.

3. *Rhomboideus major*.—*Arises* from spines of four or five dorsal vertebræ below the last muscle, and supraspinous ligament. *Inserted* into base of scapula from spine to lower angle. (Only the upper and lower fibres are fixed to bone, the rest end in an aponeurotic arch attached above and below to vertebral border of scapula).

Third Layer.

Three muscles. Splenius, serratus posticus superior and inferior:

1. *Splenius*.—This muscle is divided externally into two parts. *Arises* from six upper dorsal spines, seventh cervical, and ligamentum nuchæ as high as third cervical vertebra. Of its two parts the *splenius colli* is *inserted* into posterior transverse process of upper three cervical vertebræ, the *splenius capitis* into apex and hinder border of mastoid process and bone behind it for about an inch and a half.

2. *Serratus posticus superior*.—*Arises* from ligamentum nuchæ and spines of last cervical and two or three upper dorsal vertebræ. *Inserted* into second, third and fourth ribs external to their angles.

3. *Serratus posticus inferior*.—*Arises* from last two dorsal and first three lumbar spines. This aponeurotic origin is closely united with that of the latissimus dorsi and fascia lumborum. *Inserted* into last four ribs.

Fourth Layer.

This layer contains:

1. Spinalis dorsi.
2. Erector spinæ, dividing opposite last rib into:
 - (a) Ilio-costalis or sacro-lumbalis, which is continuous with:
 - i. Musculus accessorius ad sacro-lumbalem.
 - ii. Cervicalis ascendens.
 - (b) Longissimus dorsi, which splits into:
 - i. Transversalis colli.
 - ii. Trachelo-mastoid.

3. Complexus, the inner part of which is sometimes described as a separate muscle, the *biventer cervicis*.

Fifth Layer.

This layer contains :

1. Rectus capitis posticus major.
2. Rectus capitis posticus minor.
3. Obliquus inferior.
4. Obliquus superior.
5. Semispinalis.
6. Interspinales.
7. Intertransversales.
8. Multifidus spinæ.
9. Rotatores dorsi.
10. Levatores costarum.

3. PARTS COVERED BY TRAPEZIUS MUSCLE.

The structures concealed by the trapezius muscle are :

1. Splenius.
2. Complexus (in part).
3. Levator anguli scapulæ.
4. Rhomboidei, major and minor.
5. Erector spinæ (in part).
6. Latissimus dorsi (in part).
7. Supra-spinatus.

4. THE LUMBAR FASCIA.

The lumbar fascia (*fascia lumborum*) is the posterior aponeurosis or tendon of the transversalis abdominis muscle, and occupies the space between the last two ribs and iliac crest. It divides into three layers, enclosing the quadratus lumborum and erector spinæ muscles.

The *anterior layer* passes on the abdominal surface of the quadratus lumborum to be attached to the tips and borders of the transverse processes of the lumbar vertebræ.

The *middle layer* passes over the quadratus, between it and the erector spinæ to be attached to the apices of the lumbar transverse processes.

The *posterior layer* passes over the erector spinæ to be attached to the tips of the lumbar spinous processes.

The lumbar fascia gives attachment to the internal oblique (sometimes also the external oblique) by its cutaneous surface, and is pierced by the last dorsal and ilio-hypogastric nerves.

5. CONTENTS OF SPINAL CANAL.

The following structures are included in the contents of the spinal canal, about its middle, and are met with in the order given, from without inwards.

1. Venous plexus—*meningo-rachidian veins*—between the bone and dura mater, and surrounded by loose fat.

2. Dura mater.

3. Arachnoid, parietal and visceral layers, the former merely epithelial. Between the two layers is the *arachnoid space*.

4. Pia mater, with *linea splendens* in median line anteriorly, and *ligamentum denticulatum* between the anterior and posterior roots of spinal nerves. Between the arachnoid and pia mater is the *sub-arachnoid space*, containing cerebro-spinal fluid.

5. Spinal arteries (one anterior and two posterior) with their accompanying veins ramifying in the pia mater.

6. Spinal cord with anterior and posterior roots of nerves.

NOTE. — In addition, the canal contains the spinal accessory nerve in the cervical region, and the *cauda equina* and *filum terminale* below the first lumbar vertebra.

6. THE VEINS OF THE SPINE.

The veins of the spine form plexuses along the whole length of the column, which may be divided into the following sets. They communicate by branches with each other and the general venous system. They have no valves.

A.—Dorsal Spinal Veins.

Derived from muscles and integument of back, and form a plexus over the vertebral arches. There is usually a median longitudinal vessel over the spinous processes of several vertebræ. Offsets join the vertebral vein in

the neck, the intercostal and lumbar veins, and some perforate the ligamenta subflava to join the posterior longitudinal veins inside the spinal canal.

B.—Veins of Vertebral Bodies

are contained within the vertebral bodies which communicate with those on the front of the vertebræ, and open into the

C.—Anterior Longitudinal Veins,

which are two large plexiform veins extending along the whole length of the spinal canal. They are connected with large transverse branches, which lie between the posterior common ligament and the bones. They communicate with the basilar and occipital sinuses (see Section I., p. 12) and vertebral vein. With the next set they form venous rings round the spinal canal.

D.—Posterior Longitudinal Veins

are also two, lying between the dura mater and the vertebral arches. They communicate by many cross branches with each other, and by offsets with the dorsal spinal, anterior longitudinal, and outside veins and occipital sinus.

E.—Veins of Spinal Cord.

Tortuous, small, and contained in pia mater. They form a network round the cord. Trunks lie over the anterior and posterior median fissures, and just behind anterior nerve roots. They communicate with the veins of the spinal canal.

The veins of the spinal canal open into the vertebral, intercostal, lumbar, and lateral sacral veins.

7. ARTICULATIONS OF THE VERTEBRÆ.

The bodies of the vertebræ are connected together by intervertebral discs and ligaments, the articulations by synovial joints and ligaments.

Intervertebral discs are plates composed of fibro-cartilage and fibrous tissue externally, with a pulpy central substance. The latter is elastic and formed of a

fine fibrous matrix with numerous cells. Each pulpy centre represents a degenerated portion of the notochord.

Anterior common ligament.—A strong band placed in front of the vertebral bodies, from axis to first piece of sacrum. Its superficial fibres extend from a given vertebra to the fourth or fifth below it, fibres beneath pass over bodies of one to two vertebræ, and the deepest connect contiguous vertebræ.

Posterior common ligament.—A similar ligament within the spinal canal, from axis to sacrum, and continuous above with posterior occipito-axial ligament.

Joints of articular processes.—Each one has a capsule (longest and loosest in neck) and a synovial cavity.

Ligamenta subflava.—Consist of yellow elastic tissue, and connect laminae of vertebræ from axis downwards.

Interspinous ligaments.—Are placed between the spinous processes.

Supra-spinous ligament.—Placed continuously over tips of spinous processes. Its fibres are arranged as in the anterior common ligament. From seventh cervical to sacrum.

Ligamentum nuchæ replaces the last-named ligament in the neck, extending from occipital protuberance to vertebra prominens. It consists in man mainly of white fibrous tissue, but in animals it is a strong elastic structure.

Intertransverse ligaments are bands extending between the transverse processes.

Articulations of atlas, axis, and occipital bone.—These bones are connected by synovial articulations and ligaments.

The superior articular processes of the atlas articulate with the condyles of the occipital bone, and its lower articular processes with the upper ones of the axis, by two pairs of *synovial joints* with *capsular ligaments*.

Transverse ligament of atlas.—Strong and thick, extends across the ring of the atlas, attached on each side to the tubercles below the inner borders of the superior articular processes. Between it and the anterior arch of the atlas the odontoid process of the atlas turns. From its posterior surface a bundle passes to the basilar process of the occipital bone, and a similar one

to the body of the axis. Hence this ligament is sometimes called *crucial*.

There are *two synovial cavities*, one in front and one behind the odontoid process.

Lateral, alar odontoid or check ligaments.—Two short, strong bundles from summit of odontoid process to inner side of each occipital condyle.

Middle odontoid or suspensory ligament passes from odontoid summit to anterior margin of foramen magnum.

Posterior occipito-axial ligament covers the cruciform and odontoid ligaments. Attached to basilar groove of occipital bone to body of axis.

Anterior occipito-atlantal ligament.—From anterior border of foramen magnum to anterior arch of atlas.

Anterior atlanto-axial ligament.—From anterior arch of atlas to body of axis.

Posterior occipito-atlantal ligament.—From posterior margin of foramen magnum to posterior arch of atlas.

Posterior atlanto-axial ligament.—From posterior arch of atlas to arch of axis. Perforated by second cervical spinal nerve. Takes the place of the ligamenta subflava.

Section V.—UPPER EXTREMITY.

1. THE COSTO-CORACOID MEMBRANE.

The costo-coracoid membrane is a sheath of fascia derived from and continuous with the deep cervical and deep pectoral fasciæ, which encloses the axillary vessels for a short distance at their upper part, and corresponds to the femoral sheath in the lower limb. It extends from coracoid process of scapula to inner extremity of first rib at the origin of subclavius muscle. Above, it is continuous with deep cervical fascia, and forms the sheath of subclavius, being attached to the margins of the groove in which that muscle is inserted. From the costo-coracoid membrane a thin lamina is prolonged downwards to pectoralis minor, which it invests, and being continued beyond that muscle, stretches across between it and the short head of the biceps, ending below by joining the axillary fascia near lower border of pectoralis minor.

The membrane is pierced by the following structures :

1. Acromio-thoracic artery.
2. Superior thoracic artery.
3. Cephalic vein.
4. External anterior thoracic nerve.

2. THE AXILLA.

The axillary space is conical in form, situated between the upper part of the side of the chest and the inner side of the arm. It corresponds to Scarpa's triangle in the lower limb, and has the following boundaries :

In front.—Pectoralis major and minor muscles.

Behind.—Subscapularis, teres major, and latissimus dorsi muscles.

Inner side.—Upper four ribs and intercostal muscles, and upper part of serratus magnus muscle.

Outer side.—Upper part of humerus, coraco-brachialis, and biceps muscles.

The *apex* of the cone is directed upwards, and lies at the interval between the first rib, the clavicle, and the upper border of the scapula. The *base* is formed by the skin and axillary fascia stretching across from the lower border of the pectoralis major to the lower border of the latissimus dorsi.

Contents :

1. Axillary vessels and their branches.
2. Brachial plexus of nerves and its branches of distribution below the clavicle.
3. Lateral cutaneous offsets of the upper intercostal nerves.
4. Intercosto-humeral nerve.
5. About ten or twelve lymphatic glands.
6. A quantity of loose fat and areolar tissue.

NOTE.—The axilla is of surgical importance in some dislocations of the shoulder. The density of the tense axillary fascia has an important bearing on abscesses in this space.

3. STRUCTURES BENEATH THE DELTOID MUSCLE.

(a) *Bones* :

1. Head and neck of humerus.
2. Coracoid process and upper border of scapula.

(b) *Bursæ* :

3. The large *subdeltoid* bursa over the shoulder-joint.
4. The *subacromial* bursa.

(c) *Ligaments* :

5. Capsular.
6. Coraco-acromial.
7. Coraco-humeral.
8. Coraco-clavicular (trapezoid and conoid).
9. Costo-coracoid ligament and membrane (external attachments).

(d) *Muscles* :

10. Tendon of pectoralis minor.
11. Both heads of biceps.
12. Origin of coraco-brachialis.
13. Tendon of subscapularis.
14. „ „ pectoralis minor.
15. „ „ supra-spinatus.
16. „ „ infra-spinatus.
17. „ „ teres minor.
18. „ „ teres major.
19. „ „ latissimus dorsi.
20. Scapular and external heads of triceps.

(e) *Vessels* :

21. Anterior and posterior circumflex arteries and veins.
22. Acromio-thoracic artery and vein.
23. Branch of superior profunda artery and vein.

(f) *Nerves* :

24. Circumflex (from posterior of tracheal plexus).

4. THE TRIANGULAR SPACE AT THE UPPER PART OF THE ARM.

When the muscles attached to the head and neck of the humerus are cleanly dissected, a triangular space exists between the neck of the humerus and the axillary

border of the scapula, which has the following boundaries :

Above.—Teres minor muscle.

Below.—Teres major muscle.

External.—Head and neck of humerus.

This space is subdivided by the scapular head of the triceps muscle into two smaller spaces, one of which is quadrangular, and the other triangular in form. The *quadrangular* is superior, and has the following boundaries :

Above.—Teres minor.

Below.—Teres major.

Internal.—Scapular head of triceps.

External.—Head and neck of humerus.

This space *transmits* the posterior circumflex vessels and the circumflex nerve.

The boundaries of the smaller triangular space are :

Above.—Teres minor.

Below.—Teres major.

External.—Scapular head of triceps.

This space *transmits* the dorsalis scapulæ vessels.

5. ARTERIAL ANASTOMOSES ABOUT THE SCAPULA.

1. *On the venter.*—Between (1) ventral branch of supra-scapular ; (2) posterior scapular ; and (3) subscapular.

2. *In the supra-spinous fossa.*—Between (1) supra-scapular ; (2) dorsal scapular.

3. *In the infra-spinous fossa.*—Between (1) supra-scapular ; (2) dorsal scapular ; and (3) posterior scapular.

6. THE TRIANGLE IN FRONT OF THE ELBOW JOINT.

This triangle corresponds to the popliteal space in the lower limb.

Boundaries :

Externally.—Supinator radii longus.

Internally.—Pronator radii teres.

Above (base).—An imaginary line drawn across the arm through the condyles.

Apex.—Meeting of the supinator longus and pronator radii teres muscles.

The space is covered in by skin, superficial fascia and bicipital fascia, and the *floor* is formed by the lower part of the brachialis anticus and the oblique fibres of the supinator brevis muscles.

Contents (from within outwards) :

1. Median nerve.
2. Brachial artery and venæ comites. Opposite the neck of the radius the artery divides into radial and ulnar.
3. Tendon of biceps.
4. Musculo-spinal nerve. (The supinator longus and brachialis anticus muscles must be slightly separated in order to expose this nerve.)

7. ARTERIAL ANASTOMOSES ABOUT THE ELBOW-JOINT.

The following are the anastomoses which take place between the arteries about the elbow-joint :

1. *Superior profunda of brachial.*—With radial recurrent in interval between supinator longus and brachialis anticus. With posterior interosseous recurrent behind external condyle. With inferior profunda and anastomotic across the back of the arm.

2. *Inferior profunda of brachial.*—With posterior ulnar recurrent and anastomotic behind internal condyle. With superior profunda and anastomotic across back of arm.

3. *Anastomotic of brachial.*—With superior and inferior profunda arteries across back of arm. With anterior ulnar recurrent under pronator radii teres. With posterior ulnar recurrent and inferior profunda behind inner condyle.

4. *Anterior ulnar recurrent.*—With anastomotic under pronator radii teres.

5. *Posterior ulnar recurrent.*—With inferior profunda and anastomotic behind inner condyle. With posterior interosseous recurrent over olecranon.

6. *Posterior interosseous recurrent.* — With inferior profunda, superior profunda, posterior ulnar recurrent and radial recurrent behind external condyle.

7. *Radial recurrent.* — With superior profunda in interval between supinator longus and brachialis anticus. With posterior interosseous recurrent beneath radial extensor muscles.

8. ANTERIOR ANNULAR LIGAMENT, AND THE SYNOVIAL SACS OF HAND AND FINGERS.

The anterior annular ligament is about the size and shape of a postage stamp, and passes across the transverse arch of the carpus from the trapezium and scaphoid to the pisiform and unciform bones, completing the arch into a ring. On it lie the palmaris longus muscle, the ulnar artery and nerve, and the palmar cutaneous branch of the median nerve. Beneath are the flexor tendons with the median nerve.

There are two synovial sacs beneath the annular ligament. The outer, smaller, for the flexor longus pollicis, extends up the forearm for about $1\frac{1}{4}$ inches above the annular ligament, and follows the tendon to its insertion. The larger one is for the tendons of the deep and superficial flexors of the fingers. Commencing about $1\frac{1}{2}$ inches above the ligament, this sheath ends in four diverticula for the fingers. The innermost is continuous with the tendon sheath of the little finger. The remaining three end opposite the necks of the metacarpal bones, while their corresponding tendon sheaths commence above the heads of these bones. Occasionally the sheath of the index-finger communicates with the common synovial sac.

NOTE.—These facts are of surgical importance as explanatory of the variations of course taken by abscesses in the thumb and fingers.

9. GROOVES ON BACK OF RADIUS AND ULNA.

The grooves on the back of carpal ends of the bones of the forearm are as follow, from without inwards :

1. Just above styloid process of radius for extensores ossis metacarpi and primi internodii pollicis.

2. One for extensores carpi radiales longior and brevior.

3. A narrow one for extensor secundi internodii pollicis.

4. A broad one for extensores communis digitorum and indicis.

5. One between radius and ulna for extensor minimi digiti.

6. One on the ulnar for extensor carpi ulnaris.

These grooves are bridged over by the posterior annular ligament, and are furnished with synovial sacs.

10. TOPOGRAPHICAL ANATOMY OF PALM OF HAND.

The palm is concave in the centre where the skin is adherent to the palmar fascia, and on either side are the thenar and hypothenar eminences, formed respectively by the muscles of the thumb and little finger. At the upper end of the former can be felt the tubercle of the scaphoid and the ridge on the trapezium, and at the upper end of the latter the pisiform bone and the unciform process.

The skin of the palm of the hand is much creased, and three of these creases are important as indications of the structures beneath. The first, starting at the wrist, marks off the thenar eminence; the second starts from the ending of the first, crosses the hand obliquely to end on the hypothenar eminence; as it crosses the third metacarpal bone it indicates the lowest point of the superficial palmar arch. The third groove, crossing the necks of the metacarpals, corresponds to the upper limit of the synovial sheaths of the tendons of the outer three fingers, the splitting of the palmar fascia into four slips, the transverse metacarpal ligament, and the bifurcation of the digital arteries. Of the creases on the fingers, the highest ones are nearly $\frac{3}{4}$ inch below the metacarpophalangeal joints, the middle ones are exactly opposite the first interphalangeal joints, and the lowest folds are a little above (1 to 2 mm.) the corresponding joints. A line drawn across the palm from the palmar border of the thumb when outstretched at right angles to the index-

finger will indicate the level reached by the superficial palmar arch ; the deep arch is $\frac{1}{4}$ to $\frac{1}{2}$ an inch nearer to the wrist, lying on the bases of the metacarpal bones.

11. MUSCLES OF THE THUMB.

The short muscles of the thumb are five in number :

1. *Abductor pollicis*.—*Arises* from ridge of trapezium (or tuberosity of scaphoid), but mainly from anterior annular ligament. *Inserted* into radial side of base of first phalanx of thumb.

2. *Opponens pollicis*.—*Arises* from annular ligament and ridge of trapezium. *Inserted* into whole length of radial border and adjacent palmar surface of metacarpal bone of thumb.

3. *Flexor brevis pollicis*. *Outer head*.—*Arises* from annular ligament. *Inserted* into outer side of base of first thumb phalanx. *Inner head*.—*Arises* from upper part of first metacarpal bone on ulnar side. *Inserted* with adductor obliquus into inner side of base of first phalanx.

4. *Adductor obliquus pollicis*.—*Arises* from upper ends of second and third metacarpal bones, os magnum, anterior carpal ligaments and sheath of flexor carpi radialis. *Inserted* inner side of base of first thumb phalanx.

5. *Adductor transversus pollicis*.—*Arises* from lower two-thirds of palmar aspect of third metacarpal. *Inserted* with adductor obliquus and inner head of flexor brevis.

Nerves.—The median supplies abductor, opponens, and outer head of flexor brevis by a recurrent branch given off soon after the nerve emerges from beneath the annular ligament ; the ulnar supplies adductors and inner head of flexor brevis.

12. MUSCLES OF THE LITTLE FINGER.

Abductor minimi digiti.—*Arises* from pisiform bone. *Inserted* into base of first phalanx of little finger.

Flexor brevis minimi digiti.—*Arises* from annular ligament and tip of unciform process. *Inserted* with abductor.

Opponens minimi digiti.—*Arises* from annular ligament and unciform process. *Inserted* into ulnar side of fifth metacarpal bone in all its length.

Nerves.—All three muscles are supplied by the deep branch of the ulnar nerve.

The consideration of the interossei and lumbricales muscles will be deferred until those of the foot are discussed (see Section VI., p. 104).

13. THE ANATOMICAL SNUFFBOX.

The anatomical snuffbox (*tabatière anatomique*) is the little hollow between the extensores ossis metacarpi and primi internodii pollicis and the extensor secundi. Its floor is formed by parts of the scaphoid and trapezium and the joint between the latter and the first metacarpal bone. Crossing it is the radial artery, over which lie the terminal branch of the radial nerve, branches of the external cutaneous nerve and the cephalic vein of the thumb.

14. VEINS OF UPPER EXTREMITY.

A.—Superficial.

The veins from the hand and fingers form a *posterior plexus* on the dorsum of the wrist, from which the chief veins of the forearm arise. The vein from the little finger (*vena salvatella*) empties into the posterior ulnar, that from the thumb (*cephalic vein of thumb*) is continued on as the radial vein.

1. *Radial vein*.—Arising from the outer side of the dorsal plexus, ascends along the radial side of the forearm, receiving numerous branches on its way, and joins the median-cephalic vein.

2. *Posterior ulnar vein* begins in the inner part of the dorsal plexus and passes upwards along the posterior aspect of the ulnar side of the forearm, turning forwards just below internal condyle to join the median-basilic vein.

3. *Anterior ulnar*.—Starts from the ulnar side of the dorsal plexus, ascends along the inner side of the forearm, and joins either the posterior vein or the median-basilic vein.

4. *Median vein*.—Is small ; it commences on the front of the wrist from several small veins in the hand, passes up the front of the forearm, freely communicating with the veins on either side, to the hollow in front of the elbow, where it receives the *deep median vein* from the deep venæ comites. It then bifurcates into *median-cephalic* and *median-basilic veins*.

5. *Median-cephalic*.—Inclines outwards between biceps and supinator longus muscles, and joins the radial to form the *cephalic vein*.

6. *Median-basilic*.—Inclines inwards, passing over the bicipital fascia, and, joined by the ulnar veins, forms the *basilic vein*.

7. *Cephalic vein*.—Passes upwards along the outer border of the biceps, is directed towards the chest in the groove between pectoralis major and deltoid, and opens into the axillary vein between the subclavius and pectoralis minor muscles, crossing the first part of the axillary artery. Occasionally a communicating branch (*jugulo-cephalic*) passes over the clavicle, connecting it with the external jugular, or the cephalic may open into that vein.

8. *Basilic vein*.—Ascends along the inner border of the biceps muscle to the middle of the arm, where it pierces the deep fascia at the spot where the internal cutaneous nerve becomes external, and is continued upwards to the axillary vein.

B.—Deep.

The brachial artery and its branches are accompanied by *venæ comites* (two each), whose distribution corresponds to that of the arteries they accompany.

1. *Brachial veins*.—Join axillary vein at lower margin of subscapularis muscle ; one may, however, join the basilic vein where it pierces the fascia.

2. *Axillary vein*.—Commences at lower border of teres major muscle and terminates in the subclavian vein at outer border of first rib. It receives the following tributaries :—Two circumflex, subscapular, long thoracic, alar thoracic, acromio-thoracic, superior thoracic, and cephalic veins.

3. *Subclavian vein*.—Is in front of and on a slightly lower

level than its artery, continues the axillary, and join the internal jugular to form the innominate vein (see Section II., p. 47).

15. LYMPHATIC GLANDS OF UPPER EXTREMITY.

1. *Epitrochlear gland*.—This gland is placed just above the internal condyle of the humerus. There may be more than one. Through it pass some of the superficial lymphatics of the forearm. It is the lowest gland in the upper extremity. Occasionally one or two glands are found at the bend of the elbow.

2. *Brachial glands*.—A few on the brachial artery.

3. *Axillary glands*.—These glands are twelve or more in number, and are divided into the following groups:

(a) *Axillary* proper, on axillary artery (four to six). *Receive* lymphatics from limb.

(b) *Pectoral* (four or five) on serratus magnus muscle, near long thoracic artery. *Receive* from mamma and front of chest.

(c) *Subscapular* (three or four) on subscapular artery. *Receive* from back.

(d) *Infraclavicular* (one or two) immediately below clavicle. *Receive* from outer side of arm and shoulder, and are connected with inferior cervical and axillary glands.

The efferent ducts from these glands join to form the *axillary lymphatic trunk*, which empties into the right lymphatic or thoracic duct.

The *lymphatics* of the upper limb are *superficial* and *deep*; the former accompany, for the most part, the superficial veins, the latter the deep blood-vessels.

16. ARTICULATIONS OF UPPER EXTREMITY.

A.—Sterno-Clavicular Articulation.

The articular surface of the clavicle is much larger than that of the sternum, and there is an interposed fibro-cartilage. It is surrounded by a *capsular ligament*.

Movements.—The clavicle can be moved upwards, downwards, backwards, forwards, or in any intermediate direction, the scapula gliding with it.

Ligaments :

1. *Capsular*, divided into *anterior* and *posterior sterno clavicular*.
2. *Interclavicular*, a dense fasciculus between the sternal ends of the clavicles and attached between to the sternum at the supra-sternal notch.
3. *Interarticular fibro-cartilage*, attached above to upper part of inner end of clavicle, and below to first rib cartilage.

Synovial cavities.—Two, one on each side of fibro-cartilage. The outer and inferior one is continued between the clavicle and the first costal cartilage.

Rhomboid (costo-clavicular) ligament, is between rhomboid depression on under surface of sternal end of clavicle and sternal end of first rib.

B.—Scapulo-Clavicular Articulation.

i. *Acromio-clavicular articulation*. — Between outer end of clavicle and inner border of acromion by oval facets. It has *superior* and *inferior ligaments* and occasionally a wedge-shaped interarticular *fibro-cartilage*. It permits of gliding movement.

ii. *Coraco-clavicular ligament*, is divided into two parts :

- (a) *Conoid ligament*, between inner part of root of coracoid process and conoid tubercle of clavicle. Its fibres slope backwards and upwards.
- (b) *Trapezoid*, between posterior half of upper surface of coracoid process and trapezoid line of clavicle.

Between the two ligaments is a *bursa*.

C.—Shoulder-joint.

The shoulder is an enarthrodial joint, allowing of angular movement in all its varieties, as well as of rotation. The bones concerned are the head of the humerus and the glenoid cavity of the scapula, both covered with a layer of cartilage.

Ligaments :

1. *Capsular*, attached to scapula around margin of glenoid cavity and to humerus at anatomical neck. It is perforated opposite the bicipital groove for the passage of the long tendon of the biceps muscle, and is of great laxity.
2. *Coraco-humeral* extends obliquely across joint, from root and outer border of coracoid process to neck of humerus, above great tuberosity.
3. *Glenoid*, a fibrous band fixed to edge of glenoid fossa, which it deepens.

Synovial membrane is complicated in form, owing to its relation with the biceps and subscapularis muscles. The former it encloses in a tubular sheath, while, beneath the latter, it sends a pouch on to the venter of the scapula.

Superficial to the muscles covering the top of the joint is the large *subacromial bursa*, which may communicate with the synovial cavity.

Blood supply.—Suprascapular, anterior and posterior circumflex and dorsalis scapulæ arteries.

Nerves from suprascapular and circumflex.

Relations.—The shoulder-joint is immediately surrounded by the following muscles : supraspinatus, infraspinatus, teres minor, subscapularis, biceps (long tendon), and triceps (long head). The axillary vessels and nerves lie to the inner and inferior part of the joint, a point of surgical importance, as these structures may be seriously damaged in injuries to the shoulder.

D.—Articulations of Bones of Forearm.

The radius and ulna are united by a superior and inferior articulation and an interosseous membrane.

(a) *Superior radio-ulnar articulation*.—The head of the radius is received into the lesser sigmoid cavity of the ulna and held in position by the *orbicular (annular) ligament*, which is attached in front and behind to the extremities of the lesser sigmoid cavity and lined by a prolongation of the synovial membrane of the elbow-joint. This pivot joint (*trochoidal*) allows of free rotation of the radius.

(b) *Inferior radio-ulnar articulation*.—The lower end of the ulna is received in the sigmoid cavity of the radius. In front and behind are a few scattered ligamentous fibres. Attached by its base to the border separating the ulnar and carpal articular surfaces of the radius is a *triangular fibro-cartilage*, whose apex is fixed at the root of the styloid process of the ulna. Above this cartilage is a very loose *synovial sac* (*membrana sac-ciformis*).

Interosseous membrane.—Strong and fibrous, fibres directed obliquely downwards and inwards, from the interosseous border of the radius to that of the ulna. Its superior border lies about an inch below the tuberosity of the radius, and through the space thus left pass the posterior interosseous vessels. The *oblique ligament* is a thick band above this space, attached to just below tuberosity of radius and outer part of tuberosity of ulna.

E.—Elbow-joint.

The elbow-joint is a ginglymoid joint between the lower articular end of the humerus, the head of the radius, and the greater sigmoid cavity of the ulna.

Movements.—Flexion and extension.

Ligaments :

1. *Internal lateral*.—Triangular in shape. Between lower and fore part of internal condyle and coronoid process, along inner margin of sigmoid cavity (*anterior fibres*), under and back part of inner condyle to inner border of olecranon (*posterior fibres*). The *middle fibres* bridge over the notch between the olecranon and the coronoid process.
2. *External lateral*.—Shorter, narrower, and connected with tendinous attachment of extensor muscles. Attached above to a depression just below outer condyle and below the orbicular ligament.
3. *Anterior ligament*.—A thin sheet of fibres extending from above coronoid and radial fossæ of humerus to coronoid process and orbicular ligament below.

4. *Posterior ligament*.—Thin and weak. Attached above to margins of olecranon fossa of humerus to olecranon process. Transverse fibres pass across olecranon fossa. This ligament completes the *capsule* of the joint. The *synovial membrane* is loose and vascular, extending up as far as the coronoid and olecranon fossæ of the humerus. Below, it sends a prolongation to line the orbicular ligament, forming the synovial membrane for the superior radio-ulnar articulation.

Blood supply.—From the anastomosis around the elbow (see p. 85).

Nerve supply.—Ulnar and musculo-cutaneous.

Relations :

In front.—Brachialis anticus and biceps muscles.
Brachial artery and median nerve.

Behind.—Triceps and anconeus.

Internally.—Origin of pronators and flexors. Ulnar nerve and inferior profunda artery.

Externally.—Supinator brevis, and origin of extensors ; and, towards the front, superior profunda artery and musculo-spiral nerve dividing into radial and posterior interosseous.

F.—Wrist-joint and Carpus.

The *wrist-joint* is formed between the radius and triangular fibro-cartilage above, and the scaphoid, lunar, and cuneiform bones below. The *ligaments* are :

1. *Internal lateral*.—Between styloid process of ulna and cuneiform and pisiform bones.
2. *External lateral*.—From styloid process of radius and scaphoid bone (depression between tuberosity and radial facet).
3. *Anterior*.—Broad and membranous, from radius and ulna to scaphoid, lunar and cuneiform bones and os magnum.
4. *Posterior*.—From extremity of radius to posterior surfaces of first row of carpal bones (especially the cuneiform).

The carpal articulations.—The two rows of carpal bones are united by *dorsal*, *palmar*, and *lateral* ligaments. The last-named are two, and connect the scaphoid and trapezium, and pyramidal and cuneiform respectively. The bones of each row have, in addition, *interosseous* ligaments. The pisiform bone articulates separately with the cuneiform, having a special *capsule*.

The carpo-metacarpal and inter-metacarpal articulations.—The second, third, and fourth metacarpal bones are united by *dorsal* ligaments (two to each bone) and by *palmar* ligaments (one to each bone). The fifth bone is articulated to the cuneiform by a thin *capsule*, which is deficient on the radial side. The four inner metacarpal bones are bound together by the *transverse metacarpal* ligament, formed by fibres passing between the palmar ligaments of the carpo-metacarpal phalangeal articulations. They have also *dorsal*, *palmar*, and *interosseous* ligaments.

The metacarpal of the thumb is articulated by a complete *capsule* with the trapezium.

Synovial membranes about the wrist.—These are *five* in number :

1. The membrana sacciformis (see page 94).
2. One between the radius and ulnar and the upper row of carpal bones.
3. One between the upper and lower row of carpal bones, which sends prolongations upwards between the upper three bones and downwards between the lower four bones and the inner four metacarpals, and the carpal bones with which they articulate.
4. One between the pisiform and cuneiform bones.
5. One between the thumb metacarpal and trapezium.

Blood and nerve supplies.—The wrist-joint and carpal articulations are supplied by the anterior and posterior carpal arches, the radial, ulnar, and posterior interosseous arteries. The nerves are from the ulnar and anterior and posterior interosseous.

Movements.—The movements at the wrist take place partly in the radio-carpal and partly in the transverse carpal articulations. Flexion is most free, but some over-extension is permitted. The hand can also be laterally moved.

Relations of wrist-joint.—Flexor tendons in front and extensor tendons behind. The median nerve is separated from the anterior ligament by the flexor profundus digitorum. Over the external lateral ligament winds the radial artery, and to the radial side of the flexor carpi ulnaris are the ulnar artery and nerve.

G.—Metacarpo-phalangeal and Interphalangeal Articulations.

The proximal phalanges are united to the metacarpal bones by *lateral* and *anterior* ligaments, and each joint has a synovial membrane. The *interphalangeal* articulations are similar to these. The dorsal expansions of the extensor tendons take the place of dorsal ligaments. These joints are supplied by the digital arteries and nerves.

Section VI.—THE LOWER EXTREMITY.

1. THE FASCIA LATA.

The fascia lata or deep fascia of the thigh is strong and dense, forming a continuous sheath round the limb. Its *superior attachments* are: back of sacrum and coccyx, crest of ilium, Poupert's ligament, body and rami of pubes, ramus and tuberosity of ischium, and lower margin of great sacro-sciatic ligament. In the buttock it divides into two layers to encase the gluteus maximus muscle. The following special parts of the fascia lata require separate mention:

(a) *Ilio-tibial band.*—A strong process, formed by a thickened portion of the fascia, attached above to the crest and anterior superior iliac spine, and below to the outer tuberosity of the tibia. Into it is inserted the tensor vaginæ femoris. It acts as a brace to the limb, and, in the erect position, helps to steady the pelvis on the thigh.

(b) *Saphenous opening.*—The aperture in the fascia lata through which the internal saphenous vein passes to join the femoral vein. It lies in front of the femoral vessels and is bounded by a crescentic margin, the *falci-form border* (*falciform process of Burns*), to which is

attached the *cribriform fascia* (part of deep layer of superficial fascia), and which ends superiorly and inferiorly in curved extremities—the *superior* and *inferior cornua*, the former describes the larger curve and is called the *femoral ligament*, passing to the inner side of the femoral sheath. The inferior cornu lies in the angle between the femoral and internal saphenous veins.

(c) *Iliac and pubic portions*.—Those parts of the fascia lata on the outer and inner side of the saphenous opening are called the *iliac* and *pubic* portions respectively. The former is connected above with Poupart's ligament, and forms the falciform margin of the saphenous opening. The latter (*pectineal fascia*) is attached to the ilio-pectineal line, going behind the femoral sheath.

(d) The fascia lata has also deep processes passing between the muscles of the thigh. At the lower part of the thigh are the *external* and *internal intermuscular septa*, which are attached to the linea aspera of the femur, and separate the extensor from the adductor and hamstring muscles.

2. THE CRURAL CANAL AND COVERINGS OF FEMORAL HERNIA.

The *crural* or *femoral canal* is a funnel-shaped interval which exists within the femoral sheath, between its inner wall and the femoral vein, for the passage of lymphatic vessels. It is of surgical importance as being the space into which the sac of a femoral hernia is protruded. It is limited above by the *crural* or *femoral ring*, and is lost below by the adhesion of the sheath to the coats of the vessels. In the normal condition the canal is occupied by loose cellular tissue with numerous lymphatic vessels which perforate cribriform fascia covering the saphenous opening in the fascia lata and the walls of the sheath, to enter the abdomen or reach a lymphatic gland, sometimes present at the crural ring. This gland (when present) is retained in position by a thin layer of sub-serous tissue—the *septum crurale*—which, together with the peritoneum, separates the canal from the abdominal cavity. The *crural ring* is the opening through which a femoral hernia leaves the abdomen, and is the most frequent seat of strangulation ; its boundaries are :

In front.—Poupart's ligament.

Behind.—Ilio-pectineal line and body of pubis.

Externally.—Femoral vein.

Internally.—The margin of Gimbernat's ligament.

Relations of Crural Canal.

In front.—Poupart's ligament and iliac portion of fascia lata.

Behind.—Pubic portion of fascia lata, ramus of pubes and pectineus muscle.

Externally.—Femoral vein.

Internally.—Gimbernat's ligament.

The apex reaches to the top of the saphenous opening.

The **Coverings of a femoral hernia**, commencing at the surface, are :

1. Skin and superficial fascia.
2. Cribriform fascia.
3. Anterior layer of femoral sheath (see note).
4. Septum crurale.
5. Peritoneal sac.

[NOTE.—The sheath of the femoral vessels is formed in front by a continuation of the transversalis fascia, and behind by a similar prolongation of the iliacus fascia.]

3. SCARPA'S TRIANGLE.

This triangle is situated at the upper part of the anterior surface of the thigh, immediately below the fold of the groin. It corresponds to the axilla in the upper limb, and has the following boundaries :

Externally.—Sartorius.

Internally.—Adductor longus.

Above (base).—Poupart's ligament.

Apex.—Meeting of adductor longus and Sartorius.

The *roof* is formed by skin, superficial fascia, fascia lata, and cribriform fascia ; and the *floor* by (from without inwards) the following muscles : iliacus, psoas, pectineus, and, after dissection, a small part of the adductor brevis.

Contents :

1. Femoral sheath, derived from iliacus and transversalis fasciæ.
2. Femoral artery giving off the following branches :
Superficial circumflex iliac, epigastric and external pudic, deep external pudic, profunda femoris.
3. Femoral vein, here joined by internal saphenous and profunda veins.
4. Anterior crural nerve and its branches.
5. Crural branch of genito-crural nerve.
6. Deep lymphatic glands and vessels and fatty tissue.

4. STRUCTURES BENEATH THE GLUTEUS MAXIMUS MUSCLE.

Bones :

1. Ischial tuberosity.
2. Great trochanter.

Ligaments :

3. Great sacro-sciatic.

Bursæ :

4. Bursa over great trochanter.
5. Bursa over ischial tuberosity.
6. Bursa between it and upper part of vastus externus muscle.

Muscles :

7. Part of gluteus medius.
8. Lower border of gluteus minimus (in some subjects).
9. Piriformis.
10. Gemelli, superior and inferior.
11. Tendon of obturator internus.
12. Quadratus femoris.
13. Origins of hamstrings (semimembranosus, semitendinosus, and biceps).
14. Upper part of adductor magnus.

Vessels :

15. Superficial branch of gluteal arteries.
16. Sciatic vessels.
17. Pudic vessels.

Nerves :

18. Pudic nerve.
19. Sciatic nerves (great and small).
20. Nerve to obturator internus.

[NOTE.—The tendon of the obturator internus cannot be seen until the quadratus femoris is reflected.]

5. THE POPLITEAL SPACE.

The popliteal space is situated at the back of the knee-joint, forming the ham, and corresponding to the triangle in front of the elbow in the upper limb. It is lozenge-shaped, and has the following boundaries :

Externally.—*Above*, biceps. *Below*, outer head of gastrocnemius and plantaris muscles.

Internally.—*Above*, semitendinosus, semimembranosus, gracilis, and sartorius muscles. *Below*, inner head of gastrocnemius.

The *floor* is formed by the popliteal surface of the femur, the posterior ligaments (of Winslow) of the knee-joint, and the popliteus muscle covered by its fascia (which is derived from the tendon of the semimembranosus muscle). The space is covered in by skin, superficial and deep fascia, with the small sciatic nerve and some of its branches therein.

Contents :

1. Popliteal vessels and their branches.
2. Termination of external saphenous vein.
3. Internal and external popliteal nerves and their branches.
4. Articular branch of obturator nerve.
5. Four or five small lymphatic glands.
6. Fat, and loose areolar tissue.

6. THE CRUCIAL ANASTOMOSIS.

In the neighbourhood of the digital fossa of the great trochanter is an anastomosis between four arteries, the terminal branch of the internal circumflex, branches of the sciatic, gluteal, and first perforating. Between the lower border of the quadratus femoris and the upper border of the adductor magnus is another anastomosis ;

between the transverse branch of the internal circumflex, the sciatic, and the terminal part of the middle division of the external circumflex. There is thus an arterial circle completed around the upper part of the femur, to which the name *crucial anastomosis* is given.

7. ARTERIAL ANASTOMOSES ABOUT THE KNEE-JOINT.

The most important of the anastomoses around the knee lie anteriorly in the form of the following three transverse arches :

1. The superior arch in superficial fibres of quadriceps muscle, close to upper border of patella, formed between the superior external articular (of the popliteal) and the deep branch of the anastomotica.

2. The middle arch lies just below the inferior border of the patella (both this and the next are under cover of the ligamentum patellæ), between the inferior external articular, the anastomotica, and the superior internal articular arteries.

3. The inferior arch lies upon the tibia, just above its tubercle, and is formed by the inferior internal articular and recurrent tibial arteries.

The anastomoses on the posterior aspect of the knee-joint are unimportant and inconstant. They are formed by twigs from all the articular branches of the popliteal.

8. MUSCLES OF THE BIG AND LITTLE TOES.

The small muscles acting on the great and little toes are six, four of which belong to the former and two to the latter.

A.—Great Toe.

1. *Abductor hallucis*.—Arises from the inner part of the larger tubercle of the os calcis, the internal annular ligament, the septum between it and the flexor brevis digitorum, and the plantar fascia. Inserted into inner border of base of first phalanx of great toe, its tendon being previously joined by the inner head of the flexor brevis hallucis.

2. *Flexor brevis hallucis*.—Arises from inner border of

cuboid, and the offset of the tibialis posticus tendon passing to external and middle cuneiform bones. Dividing into two bellies, it is *inserted* into either border of base of first phalanx of big toe, the inner one joining the abductor, the outer the adductors.

3. *Adductor obliquus hallucis* (formerly called adductor hallucis).—*Arises* from sheath of peroneus longus, and tarsal extremities of third and fourth metatarsal bones. *Insertion*—Outer border of base of first phalanx of great toe.

4. *Adductor transversus hallucis* (formerly called transversus pedis).—*Arises* from inferior metatarso-phalangeal ligaments of outer three toes, and from transverse metatarsal ligament. *Inserted* into outer side of base of first phalanx of great toe.

Nerves.—Abductor and flexor brevis by internal plantar, adductors by external plantar.

[NOTE.—The *opponens hallucis* occasionally occurs, passing to the first metatarsal bone as a slip from the adductor obliquus.

B.—Little Toe.

1. *Abductor minimi digiti*.—*Arises* from front of both tubercles on under surface of os calcis, from external intermuscular septum and plantar fascia. *Inserted* into outer side of base of first phalanx of great toe.

2. *Flexor brevis minimi digiti*.—*Arises* from base of fifth metatarsal and sheath of peroneus longus. *Inserted* into base and external border of phalanx of little toe.

Nerves.—Both these muscles are supplied by the external plantar nerve.

[NOTE.—The flexor brevis minimi digiti has often some fibres inserted into the shaft of the fifth metatarsal bone—this represents the *opponens minimi digiti*.]

9. LUMBRICALES AND INTEROSSEI MUSCLES.

The consideration of these muscles in the hand was deferred until those in the foot could be discussed, in order that some comparison might be made between them.

A.—Lumbricales.

These muscles receive their name from their worm-like appearance ; there are four in the hand and four in the foot. In the hand they *arise* from the tendons of the flexor profundis digitorum ; in the foot, from those of the flexor longus digitorum (which corresponds with the flexor profundus of the upper limb), their insertion being into the expansion on the dorsum of the fingers and toes of the extensores communes digitorum of the hand and foot respectively.

HAND.

Each lumbrical muscle *arises* from the radial border of a tendon, the inner two being also attached to the ulnar sides of the second and third tendons. Each muscle ends in a small tendon, which winds round the radial side of a finger at the web, to be *inserted* into the expansion of the extensor communis digitorum.

Nerves.—The two *outer* are supplied by the third and fourth digital branches of the median, the two *inner* by the deep branch of the ulnar.

FOOT.

Each lumbricalis *arises* from the contiguous sides of two tendons, with the exception of the innermost muscle, which is attached to the tibial side of the tendon to second toe only. Each muscle ends in a small tendon, which winds to the inner side of its toe at the web, to be *inserted* into the expansion of the extensor communis digitorum.

Nerves.—The *outer three* are supplied by the external plantar, the *innermost* by the internal plantar.

B.—Interossei.

The interossei are seven in the hand (three *palmar* and four *dorsal*), and seven in the foot (three *plantar* and four *dorsal*). The attachments can be readily understood by bearing in mind their actions and the line towards or from which they bring the fingers or toes. The palmar and plantar interossei are *adductors*, the dorsal are *abductors*. In the hand, the line to and from which they act passes through the middle finger ; in the foot this imaginary line passes through the second toe.

Palmar of Hand.—As it is manifestly impossible to bring the middle finger nearer to its own line it naturally requires no muscle. The three palmar interossei *arise*, therefore, in the following manner: the *first* from the ulnar side of the second metacarpal bone, the *second* and *third* from the radial sides of the fourth and fifth metacarpal bones respectively. Each muscle ends in a small tendon, which is *inserted* partly into the base of the first phalanx on the same side as it arose from the corresponding metacarpal, partly into the extensor tendon.

Plantar of Foot.—The same argument applying to the second toe, the plantar interossei *arise* from the inner sides of the three outer metatarsal bones, and are *inserted* similarly to the palmar muscles in the hand.

Dorsal of Hand.—Since the imaginary line passes through the middle finger, that digit can be abducted from its line to either the radial or ulnar side; it therefore requires two muscles to act upon it. The four dorsal interossei have, in consequence, the following attachments:

Origins.—The *first* from contiguous sides of first and second metacarpals, the *second*, *third*, and *fourth* from contiguous sides of second and third, third and fourth, fourth and fifth metacarpals respectively. The muscles end in small tendons, which are thus *inserted* partly into the bases of the first phalanges, partly into the common extensor expansions; the *first* and *second* into the radial sides of their phalanges, the *third* and *fourth* into the ulnar sides.

Dorsal of Foot.—Similarly the second toe can be moved away from its own line on either side, and consequently the dorsal interossei, *arising* from the contiguous sides of the metatarsal bones between which they lie, are *inserted* thus into the bases of the first phalanges and extensor expansions: the *first* into inner side of its phalanx, the *second*, *third*, and *fourth* into the outer sides of their phalanges.

Nerves.—The interossei of the hand and foot are supplied by the ulnar and external plantar nerves respectively (the latter being the homologue of the former).

10. VEINS OF LOWER EXTREMITY.

As in the upper limb, the veins of the lower extremity may be divided into two sets, *superficial* and *deep*.

A.—Superficial.

The veins of the sole of the foot form a plantar plexus from which offsets pass through the interdigital spaces to join the dorsal veins. At the margins of the foot they receive branches from the deep vessels, and end in the internal and external saphenous trunks.

1. *Internal* or *long saphenous*.—Arising at the inner part of the dorsal plexus, it passes in front of the internal malleolus to ascend the leg behind the inner border of the tibia with the internal saphenous nerve. It then passes behind the internal condyle of the femur and ascends along the inner and fore-part of the thigh (along the sartorius muscle), to end in the femoral vein through the saphenous opening. Its tributaries are as follow :

- (i.) Communications with deep plantar veins and venæ comites of anterior and posterior tibial arteries.
- (ii.) A posterior branch from inner and back part of thigh.
- (iii.) A large branch from the outer and back part of the thigh, ascending over the position of the femoral artery.
- (iv.) Superficial circumflex iliac, epigastric, and external pudic veins.

2. *External* or *short saphenous*.—Arising from outer side of dorsal plexus it passes behind the external malleolus to ascend, with the external saphenous nerve, along the outer border of the tendo Achillis. Then, passing over the interval between the two heads of the gastrocnemius muscle, it enters the popliteal vein. It receives communications from deep veins, numerous superficial veins, and usually is connected with the internal saphenous.

B.—Deep.

The deep veins in the leg follow the course of the arteries (*venæ comites*), from which they borrow names. At the lower border of the popliteus muscle they unite to form the *popliteal* vein, which lies superficial to the popliteal artery (crossing it from the inner to the outer side and receiving branches corresponding to those of the artery). Passing through the opening in the adductor magnus muscle, it becomes continuous with the *femoral* vein. This accompanies its artery, being placed at first external, then behind, and finally to the inner side of that vessel. It receives branches corresponding to those of the artery (except the three superficial ones, which join the internal saphenous) and terminates in the *external iliac* vein. This vessel passes from Poupart's ligament to the common iliac vein, lying at first internal and then behind the external iliac artery. It receives the *deep circumflex iliac*, *deep epigastric*, and *pubic* veins.

11. LYMPHATIC GLANDS OF LOWER EXTREMITY.

1. The lowest lymphatic gland in the lower limb is one often found about the middle of the leg on the front of the interosseous membrane, the *anterior tibial gland*.

2. *Popliteal glands*.—Four or five small glands around the popliteal vessels. *Receive* deep lymphatics of leg and a few superficial ones accompanying the external saphenous vein. Efferent vessels pass to groin with femoral vein.

3. *Superficial inguinal glands*. These vary in number and are divided into two sets.

(a) *Superior oblique*.—Lying along line of Poupart's ligament. *Receive* from integument of trunk, gluteal region, perineum and genital organs.

(b) *Inferior, femoral, or vertical*.—These surround the upper end of the long saphenous vein. *Receive* the superficial lymphatics of the lower limb. The efferent vessels of the superficial inguinal glands pass through the cribriform fascia and go with the femoral vessels to the abdomen, where they join the external iliac glands (see Section III., page 71). Some go to the deep inguinal glands.

- (c) *Deep inguinal glands*.—Two or three glands on inner side of femoral vein (one in crural ring). They receive deep lymphatics from limb, and some from superficial glands. Their efferent vessels pass through the crural canal to the external iliac glands.

12. ARTICULATIONS OF LOWER EXTREMITY.

A.—Hip-joint.

The hip-joint is an *enarthrodial*, or ball-and-socket joint, the head of the femur being received into the acetabulum of the innominate bone.

Movements allowed.—Flexion, extension, abduction, adduction, circumduction, and rotation. Of these movements, flexion is limited by the contact of the thigh with the abdominal wall, and adduction by contact with the other limb. The limits of the other movements will be seen when discussing the ligaments.

Ligaments :

1. *Cotyloid*.—A thick fibro-cartilaginous ring fixed round the margin of the acetabulum, increasing its depth and bridging over the cotyloid notch. Here some fibres pass across from one margin of the notch to the other, forming the *transverse ligament*.
2. *Ligamentum teres*.—Variable. Attached to fossa on head of femur and to the transverse ligament. Covered by synovial membrane. It is put on the stretch when the hip is partly flexed, adducted, or rotated out.
3. *Capsular*.—Attached above to margin of acetabulum (outside cotyloid ligament) and below to neck of femur. The latter attachment extends anteriorly to the intertrochanteric line, superiorly to the root of the great trochanter, posteriorly and inferiorly to the junction of the middle and external thirds of the neck. Its fibres run in two directions, circularly and longitudinally. The strong fibres on the antero-superior aspect of the capsule form the *ilio-femoral ligament*. This is attached above to

the anterior inferior iliac spine ; it then splits into two limbs, the outer (*ilio-trochanteric*) goes to the upper part of the anterior intertrochanteric line, the inner to the lower part of that line. The whole ligament is often called the *Y-ligament of Bigelow*. The ilio-femoral ligament limits rotation outwards, rotation inwards being checked by the *ischio-capsular ligament*, a set of strong fibres passing from the lower and back part of the capsule to the ischium below the acetabulum. A few fibres passing from the ilio-pectineal eminence and obturator crest and membrane to the front of the capsule constitute a *pubo-femoral ligament*, which limits abduction.

Synovial membrane.—This is reflected from the neck of the femur to the inner side of the capsule, and covers the floor of the acetabulum, sending a tubular prolongation round the ligamentum teres. It covers a pad of fat lying in the non-articular part of the acetabulum, which is called the *gland of Havers*, but which contains no glandular elements at all.

Bursæ.—There is a bursa placed beneath the ilio-psoas tendon, which may communicate with the joint-cavity.

Vascular and Nervous supply.—The former is derived from the gluteal, sciatic, obturator, and internal circumflex arteries ; the latter from the nerve to the quadratus femoris muscle, great sciatic, obturator, accessory obturator, and anterior crural (branch to rectus femoris) nerves.

Relations.—*In front* : Iliacus, psoas, pectineus, reflected tendon of rectus, part of gluteus minimus muscles. *Behind* : Piriformis, gemelli, obturatores internus and externus, and quadratus femoris muscles. *Above* : Reflected tendon of rectus and gluteus minimus muscles. *Below* : Obturator externus and outer border of pectineus muscles.

B.—Knee-joint.

The action of the knee-joint is mainly ginglymoid (hinge-joint). The bony surfaces involved are the condyles of femur, condylar surfaces of tibia, articular surface of patella, and patellar surface of femur.

Movements allowed.—The chief movements are flexion and extension, but when the knee is bent the tibia can be rotated internally or externally—the flexion of the joint relaxing the anterior crucial and lateral ligaments.

Ligaments :

1. *Internal lateral.*—Between internal tuberosity of femur and inner part of shaft of tibia.
2. *External lateral.*—From external tuberosity of femur to head of fibula. It divides the tendon of the biceps muscle into two parts.
3. *Short external lateral.*—A less constant band, lying behind the external lateral ligament and passing between external condyle of femur and styloid process of fibula.
4. *Posterior ligament* (of Winslow). — Broad and membranous. Passing between upper edge of intercondylar fossa of femur and posterior margin of head of tibia. Formed in great part by the tendinous expansion of the semimembranosus muscle.
5. *Ligamentum patellæ.*—Really the tendon of the quadriceps femoris muscle. Attached above to apex and lower border of patella, below to tubercle of tibia.
6. *Capsular.*—The name given to the fibres which invest the joint between the ligaments already named. It is incomplete. Those fibres between the sides of the patella and the femur (*lateral patella ligaments*) are connected with the insertions of the vasti muscles and fascia lata.
7. *Crucial*—These ligaments are two, and cross each other as they pass from the intercondylar fossæ to the spaces in front and behind the spine of the tibia.
 - (a) *Anterior.*—Fixed below to inner part of depression before spine of tibia, above to inner and hinder part of external condyle.
 - (b) *Posterior.*—Below to floor of popliteal notch of tibia, above to lower part of outer surface of internal condyle.
8. *Semi-lunar fibro-cartilages.* — Two crescentic plates interposed between the condyles of the

femur and the articular surfaces of the head of the tibia. Thick at the external border, each fibro-cartilage is thinned off internally to a fine edge. Their extremities are fixed to the tibial head, their circumferences are connected with the capsule. The *internal* cartilage is almost semicircular, the *external* forms nearly a complete circle. Towards the front of the joint the convex borders of the cartilages are connected by a slight *transverse ligament*.

The order of attachment of these structures to the head of the tibia is as follows, from before backwards :

1. Internal fibro-cartilage.
2. External fibro-cartilage.
3. Anterior crucial ligament.
4. External fibro-cartilage.
5. Internal fibro-cartilage.
6. Posterior crucial ligament.

Synovial membrane.—The largest in the body. Lining the capsule, it passes to the upper surfaces of the semilunar cartilages, round their free borders to their inferior surfaces and thence to the tibia. It invests the crucial ligaments. Between the tibia and patella it covers a large pad of fat, on which it forms two lateral folds (*ligamenta alariæ*), and from the middle of which it sends backwards a process to the front of the intercondylar fossa (*ligamentum mucosum*). Above, the membrane extends beneath the extensor tendon for about four fingers' breadths.

Bursæ.—The following are the most important bursæ about the knee-joint :

1. The largest, between inner condyle of femur and inner head of gastrocnemius and semimembranosus. It usually communicates with the joint.
2. One between the semimembranosus tendon and tuberosity of tibia. Never communicates with joint, but may with last-mentioned bursa.
3. One between popliteus tendon and external lateral ligament. Does not usually communicate with joint.
4. A diverticulum of the synovial membrane between popliteus tendon and outer tibial tuberosity.

5. An inconstant bursa between outer head of gastrocnemius and femoral condyle.
6. One between biceps tendon and external lateral ligament. Across this bursa runs the peroneal nerve.
7. One under the extensor muscles, above the pouch of synovial membrane, with which it frequently communicates.
8. The *bursa patellæ*, between the skin and the patella.
9. A bursa between the ligamentum patella and the tibia.
10. One between skin and tubercle of tibia.

Blood and nerve supplies.—The arteries are from the external circumflex, anastomotica, five articular branches from popliteal, and anterior tibial. Nerves from obturator, anterior crural, three from internal popliteal, and two from external popliteal.

Relations.—*In front* : the joint is nearly subcutaneous. *Behind* : popliteal vessels and internal popliteal nerve. *Externally* : outer head of gastrocnemius, plantaris, biceps, external popliteal nerve. *Internally* : semiten-dinosus, semimembranosus, gracilis, sartorius, internal saphenous vein and nerve, and superficial part of anastomototic artery.

C.—Tibio-fibular Articulations.

1. *Superior.*—Between head of fibula and facet on external tuberosity of tibia. Maintained by *anterior* and *posterior superior tibio-fibular ligaments*. The synovial membrane may communicate with the knee-joint.

2. *Interosseous membrane.*—Passes from external border of tibia to antero-internal border of fibula. The fibres run, for the most part, downwards and outwards. Superiorly is an opening for passage of anterior tibial vessels, and, inferiorly, one for anterior peroneal vessels.

3. *Inferior.*—Between lower ends of tibia and fibula, which are mostly rough, but at the lower $\frac{1}{4}$ -inch smooth, and lined by synovial membrane. There are four ligaments : (i.) *Inferior interosseous*—strong fibres passing obliquely between the opposed surfaces ; (ii.) *anterior*—a flat band, extending from tibia to fibula obliquely over

the lower part of the bones ; (iii.) *posterior*, similarly disposed behind ; and (iv.) *transverse*, lying under the posterior ligament.

The *synovial membrane* is an extension from ankle-joint.

D.—Ankle-joint.

This is a ginglymoid (or hinge) joint, between the inferior extremities of tibia and fibula and the astragalus. The inner margin of the upper surface of the latter bone is nearly straight, the outer is convex and inclined inwards posteriorly, so that the whole surface is narrower behind than in front. The *movements allowed* are flexion and extension, the whole range not exceeding 90°.

Ligaments :

1. *Internal lateral or deltoid*.—A broad set of fibres radiating from internal malleolus to astragalus, sustentaculum tali, internal calcaneo-navicular ligament, and dorsal surface of navicular bone.
2. *External lateral*.—Has three bands : *anterior*, from outer malleolus to body of astragalus ; *middle*, from tip of fibula to external surface of os calcis ; *posterior*, pit on inner side of malleolus to external tubercle of astragalus.
3. *Anterior*.—Thin and lax, from anterior margin of lower end of tibia to upper aspect of head of astragalus.
4. *Posterior*.—Weak, between tibia and fibula and astragalus, near their articulating surfaces.

Synovial membrane.—This extends into inferior tibio-fibular articulation.

Blood and nerve supplies.—Arteries from anterior and posterior tibials, malleolar and peroneals. Nerves from internal saphenous, anterior and posterior tibials.

Relations.—*Behind* : Tendo Achillis. *In front and laterally* : Tibialis anticus, extensor proprius hallucis, anterior tibial vessels and nerve, extensor longus digitorum, peronei tertius, brevis and longus, flexor longus hallucis, posterior tibial nerve and vessels, flexor longus digitorum, and tibialis posticus.

E.—Articulations of Foot.

The articulations of the tarsus may be divided into that between the astragalus and os calcis and navicular bones, that between the os calcis and cuboid, and that between the navicular, cuboid, and cuneiform bones.

1. Between the astragalus and os calcis are *interosseous*, *posterior*, and *internal* ligaments, and sometimes a slight *external* ligament. The calcaneo-navicular ligaments are *inferior* and *superior*. There is one *astragalo-navicular* ligament.

2. The *calcaneo-cuboid* ligaments are four: (a) *long plantar*, from os calcis to cuboid, and bases of third, fourth, and fifth metatarsal bones; (b) *short plantar*, from os calcis to cuboid; (c) *dorsal*; and (d) *interosseous*.

3. The remaining tarsal bones are connected with one another by *dorsal*, *plantar*, and *interosseous* ligaments.

Tarso-metatarsal Articulations.

The line of the tarso-metatarsal articulation is irregular, owing to the wedging in of the second metatarsal bone between the external and internal cuneiform bones. The bones are retained in position by *dorsal*, *plantar*, and *interosseous ligaments*. The distal ends of the metatarsal bones are connected by the *transverse metatarsal ligament*, corresponding with the similar ligament in the hand.

Synovial membranes of the foot.—These are five in number (not counting the ankle-joint):

1. Calcaneo-astragaloid (posteriorly), separated by the interosseous ligament from
2. Astragalo-calcaneo-navicular.
3. Calcaneo-cuboid.
4. A large one, common to the naviculo-cuneiform articulation, the joint between the cuboid and external cuneiform, and that between the four outer metatarsal, outer two cuneiform and cuboid bones. (Occasionally the articulations between the external cuneiform and cuboid, and the cuboid and fourth and fifth metatarsals, have separate synovial membranes, in which

case the number above given is increased from five to seven.)

5. Between internal cuneiform and first metatarsal.

The Arches of the Foot.

The foot consists of two arches, a longitudinal and a transverse. Both arches are capable of being flattened somewhat by pressure from above, thus securing elasticity. The longitudinal arch is formed by the calcaneum, astragalus, cuboid, navicular, external cuneiform and third metatarsal bones. This is supported by the strong plantar ligaments, plantar fascia, and muscles of the sole. The transverse arch lies chiefly in the tarso-metatarsal line, and is supported by the plantar interosseous ligaments.

Section VII.—THE NERVES.

A.—The Cranial Nerves.

Formerly English anatomists, in classifying these nerves, adopted the arrangement of Willis, who divided them into nine pairs, numbered according to the openings in the base of the skull. Of late years, however, this classification has rightly fallen into disuse, and that of Sæmmering is now employed. By his system twelve pairs of nerves are recognised, as follows :

1. Olfactory.
2. Optic.
3. Motor oculi.
4. Pathetic, or trochlear.
5. Trifacial.
6. Abducens.
7. Facial.
8. Auditory.
9. Glosso-pharyngeal.
10. Pneumogastric, or vagus.
11. Spinal accessory.
12. Hypoglossal.

All the cranial nerves are connected with the surface of the brain (*superficial* or *apparent origin*), and their fibres can be traced into its substance to a special centre or *nucleus* (*deep, or real origin*).

1. THE OLFACTORY NERVE.

The first, or olfactory nerves are about twenty in number, given off from the under surface of the *olfactory bulb*, which is the expanded end of a slender process of brain substance, the *olfactory tract*. The latter, at its base, is divided into three roots, *external*, *middle*, and *internal*. The fibres of the former root pass outwards, round the anterior perforated spot, across the fissure of Sylvius, to the uncinatè convolution of the temporo-sphenoidal lobe. The middle root arises just in front of the anterior perforated space, and the internal root passes inwards, its fibres going partly into Broca's area, partly into the callosal gyrus. The olfactory tract lies on the under surface of the frontal lobe in the *olfactory sulcus*, resting on the cribriform plate of the ethmoid bone. The branches of distribution (olfactory nerves proper) are given off from the under surface of the olfactory bulb, and pass through the foramina in the cribriform plate of the ethmoid bone in three groups to supply the mucous membrane of the nose (*Schneiderian membrane*). The inner set spreads out upon the upper third of the septum, the middle set are confined to the roof of the nose, and the outer set are distributed on the superior and middle turbinated bones. They are the special nerves of the sense of smell, and unite in a plexiform network, the filaments ending in the *cells of Schultze*.

2. THE OPTIC NERVE.

The second pair of nerves are concerned with the special sense of light alone.

Origin.—Each nerve arises from the corpora geniculata, superior corpus quadrigeminum and optic thalamus.

Course and distribution.—From this origin the nerve winds round the crus cerebri as a flattened band, the *optic tract*, and unites with its fellow of the opposite side in front of the tuber cinereum, to form the *optic commissure*, or *chiasma*. The optic tract is united by its outer edge with the crus cerebri and tuber cinereum; with the latter the commissure is also united, receiving some fibres from it. Beyond the commissure the nerve

diverges from its fellow, becoming rounded in form, and is enclosed in a sheath derived from the arachnoid. It then passes forward through the optic foramen into the orbit. At the optic foramen it receives a sheath of dura mater (which here splits into two layers, one forming the periosteum of the orbit, the other the nerve sheath) which invests the nerve up to the point at which it pierces the eyeball, when the sheath becomes continuous with the sclerotic. After a short course within the orbit, the nerve pierces the sclerotic and choroid coats of the eyeball, a little to the nasal side of its centre, and expands into the retina.

Optic chiasma.—Within the commissure the innermost fibres of the optic tracts cross each other to pass to opposite eyes, the outer fibres continue their course uninterrupted to the eye of the corresponding side, and some fibres pass in an arched direction from one tract to the other (*inter-cerebral*). The existence of *inter-retinal* fibres is not proved, though asserted by Stilling.

3. THE THIRD NERVE.

The third, or *oculomotor nerve*, supplies all the muscles of the orbit, except the superior oblique and external rectus, and sends motor fibres to the iris and ciliary muscle.

Origin.—Its *superficial origin* is from the inner side of the crus cerebri, close to the pons Varolii, but it may be traced into a *deep origin* in a gray nucleus in the floor of the aqueduct of Sylvius, its fibres passing through the tegmentum of the crus.

Course.—From the inner side of the crus cerebri the nerve passes forward between the posterior cerebral and superior cerebellar arteries and pierces the dura mater immediately below and external to the posterior clinoid process. It then descends obliquely into the external wall of the cavernous sinus, and divides into two branches, which enter the orbit through the sphenoidal fissure and between the heads of origin of the external rectus muscle.

Distribution.—The *superior* of its two branches ascends and supplies the superior rectus and levator palpebræ muscles. The *inferior* divides into three other

branches, one of which passes beneath the optic nerve to the internal rectus, another passes to the inferior rectus, and the third, a long branch, supplies the inferior oblique. All the muscles are supplied on their *ocular* surfaces. From the last-named branch a short, thick root is given to the lenticular ganglion.

4. THE FOURTH NERVE.

The fourth, *trochlear*, or *pathetic* nerve is the smallest of the cranial nerves, and supplies the superior oblique muscle on its *orbital* surface.

Origin.—The *superficial origin*, from the valve of Vieussens behind the corpora quadrigemina. In the valve of Vieussens the nerve crosses to the opposite side, decussating with its fellow, arches round the aqueduct of Sylvius to a nucleus in a floor of that canal immediately below the nucleus of the third nerve.

Course.—The nerve first winds round the outer side of the crus cerebri to pierce the dura mater below the third nerve, and passes forward in the outer wall of the cavernous sinus to the sphenoidal fissure, through which it passes to the orbit, becoming the highest of the nerves passing through the fissure. Entering the orbit, it crosses the levator palpebræ muscle near its origin, to the superior oblique muscle. While in the cavernous sinus it sends a branch of communication to the ophthalmic nerve, and gives off a recurrent branch, consisting of sympathetic filaments from the cavernous plexus, which is distributed to the cavernous sinus.

5. THE FIFTH NERVE.

The fifth, *trifacial*, or *trigeminal* nerve is the largest cranial nerve, and resembles in many ways a spinal nerve. It arises by two roots, motor and sensory, the latter having developed upon it a ganglion. Its function, to be seen later, is that of a compound nerve.

Superficial origin.—From the side of the pons Varolii by two fasciculi, separated by a narrow interval. The smaller, or anterior, is the *motor* root, the larger, or posterior, the *sensory*. The former consists of about twenty nerve filaments, and the latter of from seventy to a hundred.

Deep origin.—The *large root* divides within the pons into two parts; one of these passes to a gray nucleus (*sensory nucleus of fifth*), near the floor of the fourth ventricle, the other (*ascending root of fifth*) comes from the cells of the posterior horn of gray matter in the lower part of the medulla and upper part of the cord, and is directed upwards on the outer surface of the gelatinous substance of Rolando to join the upper part. The *small root* has a similar double origin, one part coming from a nucleus in the floor of the fourth ventricle internal to the sensory nucleus (*motor nucleus of fifth*), the other from a nucleus on the side of the aqueduct of Sylvius (*descending root of fifth*).

Course.—From the side of the pons Varolii the two roots pass forward through an oval opening in the tentorium cerebelli, near the apex of the petrous portion of the temporal bone. Here the posterior root spreads out into the large semilunar Gasserian ganglion, which lies on the bone in a depression. The anterior root is not connected with the ganglion, but passes beneath it and through the foramen ovale, where it unites with the inferior maxillary nerve. From the anterior or convex border of the ganglion are given off three large trunks :

- (a) The *ophthalmic division*, which passes forward in the outer wall of the cavernous sinus, and enters the orbit through the sphenoidal fissure.
- (b) The *superior maxillary division*, which passes forward through the foramen rotundum to enter the speno-maxillary fossa.
- (c) The *inferior maxillary division*, which is given off from the inferior angle of the ganglion, and makes its exit from the cranium by the foramen ovale.

[NOTE.—The Gasserian ganglion receives some filaments from the carotid plexus of the sympathetic, and gives off a few small branches to supply the tentorium cerebelli and dura mater in the middle cranial fossa.]

(a) The Ophthalmic Division.

This nerve is entirely sensory in function, and after receiving several filaments from the carotid plexus, divides into three branches: *lachrymal*, *frontal* and

nasal. Before its division it gives off a small *recurrent* branch, which passes backwards with the recurrent branch of the fourth nerve, between the layers of the tentorium cerebelli, to the wall of the lateral sinus.

The *lachrymal nerve*, the smallest of the three branches of the ophthalmic, enters the orbit through the sphenoidal fissure, external to the frontal nerve, and passes forward above the upper border of the external rectus muscle, with the lachrymal artery, to the lachrymal gland, to which it gives branches, and near which it sends downwards one or two small filaments to join the temporo-malar branch of the superior maxillary nerve.

The *frontal nerve*, the largest branch of the ophthalmic, enters the orbit, immediately to the outer side of the fourth nerve. In its course to the forehead it lies along the middle of the orbit, upon the levator palpebræ muscle, and after giving off the supra-trochlear branch, it leaves the cavity by the supra-orbital notch. Taking the name *supra-orbital*, it ascends on the forehead, dividing into two *cutaneous* branches, the inner of which goes as high as the parietal bone, the outer (large) extending as far as the ear. While in the notch it gives *palpebral* branches to the upper lid. The *supra-trochlear* passes out of the orbit above the pulley of the superior oblique, and ends in branches to the eyelid and forehead. Before leaving the orbit it sends downwards a twig of communication to the infra-trochlear branch of the nasal nerve.

The *nasal nerve* enters the orbit between the two heads of the external rectus muscle, and between the two branches of the third nerve. It crosses the optic nerve obliquely, in company with the ophthalmic artery, beneath the levator palpebræ and superior rectus muscle, to reach the inner wall of the orbit, where it enters the anterior ethmoidal foramen, through which it re-enters the cranial cavity. It then passes through the nasal slit by the side of the crista galli into the nose. Passing down behind the nasal bone it issues between that bone and the cartilage, to end on the outer side of the nose. In the orbit the nerve gives off the following branches :

1. *To lenticular ganglion*.—About half an inch long, which enters the upper angle of the ophthalmic ganglion and constitutes its long root.

2. *Long ciliary nerves*.—Two or three long filaments which pierce the sclerotic coat near the short ciliary nerves, and passing through the globe of the eye, between the sclerotic and choroid coats, are distributed to the ciliary muscle and iris.
3. *Infra-trochlear* — which arises just as the nasal nerve is about to leave the cavity, and passes forward below the pulley of the superior oblique to end in the upper eyelid, conjunctiva, and side of nose. It communicates with the supra-trochlear.

(b) The Superior Maxillary Division.

This nerve is entirely sensory in function and passes horizontally forward, leaving the skull by the foramen rotundum. Crossing the spheno-maxillary fossa, it enters the infra-orbital canal and emerges on the face at the infra-orbital foramen beneath the levator labii superioris muscle. Here it divides into a number of branches which, together with branches of the facial nerve, form a plexus—the *infra-orbital plexus*.

The branches of distribution of this nerve are divided into three groups, according to the locality in which they arise :

Spheno-maxillary fossa	{ Orbital, or temporo-malar. Spheno-palatine. Posterior dental.
Infra-orbital canal	{ Middle dental. Anterior dental.
On the face	{ Palpebral. Nasal. Labial.

The *orbital*, or *temporo-malar* branch enters the orbit through the spheno-maxillary fissure, and divides into two branches, temporal and malar. The *temporal* branch ascends along the outer wall of the orbit, receives a branch from the lachrymal nerve, passes through the malar canal and enters the temporal fossa, where it communicates with the deep temporal branches of the inferior maxillary. It then pierces the temporal muscle and fascia, and supplies the skin of the temple and side of the forehead, communicating with the facial and anterior temporal nerves. The *malar* branch passes

along the inferior angle of the outer wall of the orbit, emerges on the face by a foramen in the malar bone, and pierces the fibres of the orbicularis palpebrarum muscle to reach the skin of that region (*ramus subcutaneus malaræ*). It communicates with the infra-orbital, facial, and lachrymal nerves.

The *spheno-palatine* are two branches passing downwards to Meckel's ganglion.

The *posterior dental* are two branches which arise from the trunk of the nerve just as it is about to enter the infra-orbital canal, and pass downwards upon the tuberosity of the superior maxilla. One of the branches passes forward through the substance of the bone, giving off filaments to the molar and bicuspid teeth, the lining membrane of the antrum, and corresponding portion of the gums. It communicates with the anterior dental nerve opposite the canine fossa. The other posterior dental nerve continues its course forward, external to the bone, and is distributed to the gums.

The *middle* and *anterior dental* branches are given off in the infra-orbital canal, and descend to the corresponding teeth and to the gums. The *middle* passes beneath the lining membrane of the antrum, whilst the *anterior* passes through a special canal in the anterior wall of that cavity. Previously to their distribution, the anterior, middle, and posterior dental nerves form a plexus (*superior maxillary*) immediately above the alveolus, from which filaments are given off to supply the teeth, gums, mucous membrane of the floor of the nose, and the palate.

The *palpebral*, *nasal* and *labial* branches are very numerous, and supply the skin of the regions indicated by their names. The palpebral also supplies the conjunctiva of the lower lid, communicating with the facial nerve and the malar branch of the orbital. The nasal branches communicate with the nasal branch of the ophthalmic nerve.

(c) The Inferior Maxillary Division.

This, the largest division of the fifth nerve, consists of two parts, sensory and motor, both of which pass through the foramen ovale and unite immediately afterwards.

Immediately beneath the base of the skull the nerve divides into two trunks, anterior and posterior, the former receiving nearly all the motor fibres. These again subdivide into the following branches :

<i>Anterior Division.</i>	<i>Posterior Division.</i>
Masseteric.	Auriculo-temporal.
Deep temporal (2).	Inferior dental.
Buccal.	Lingual.
Pterygoid (2).	

The *masseteric* branch passes outwards above the external pterygoid muscle, and behind the tendon of the temporal muscle, crossing the sigmoid notch with the masseteric artery, and enters the masseter muscle. It sends a small branch to the temporal muscle, and a filament to the temporo-maxillary articulation.

The *deep temporal* branches, anterior and posterior, pass between the upper border of the external pterygoid muscle and the temporal bone to reach the deep surface of the temporal muscle which they supply. Some filaments from these nerves pierce the temporal fascia and communicate with the lachrymal, ramus subcutaneus malæ, superficial temporal and facial nerves.

The *buccal* branch pierces the lower fibres of the external pterygoid muscle, to which it gives a branch, and passes downwards, beneath the inner surface of the coronoid process of the lower jaw, or through the fibres of the temporal muscle, to reach the surface of the buccinator muscle* which it supplies, as also the skin and mucous membrane of the cheek. It also sends a few filaments to the temporal muscle, and communicates with the facial nerve.

The *pterygoid* branches, internal and external, supply the internal and external pterygoid muscles respectively. The *internal* branch is intimately connected with the otic ganglion, and supplies the tensor palati and tensor tympani muscles. The *external* branch may arise separately from the inferior maxillary nerve, but more commonly it is given off from the buccal nerve.

The *auriculo-temporal* nerve arises by two roots, embracing the middle meningeal artery. Passing back-

* By this branch the buccinator muscle receives sensation merely, its motor supply being from the seventh nerve.

ward behind the temporo-maxillary articulation, it turns upward between that joint and the ear, and, escaping from beneath the parotid gland, divides into two temporal branches. While behind the articulation, it gives off the following branches :

1. *Temporo-maxillary* to the articulation.
2. *Parotid* to the parotid gland.
3. *Meatal*, two, to the external auditory meatus.
4. *Auricular*, two, superior and inferior, to the pinna above and below the meatus. The *inferior* communicates with the sympathetic.
5. *Communicating* with the otic ganglion and facial nerve.
6. *Temporal*, two, anterior and posterior. The *anterior* accompanies the temporal artery to the vertex of the skull, supplies the skin of the temporal region, and communicates with the facial, ramus subcutaneus malæ, supra-orbital, and lachrymal nerves. The *posterior* supplies the *attrahens aurem*, upper parts of pinna, and skin of posterior part of temple.

The *inferior dental* nerve, the largest of the three branches of the third division of the fifth, passes downwards with the inferior dental artery, at first between the two pterygoid muscles, and then between the internal lateral ligament and ramus of the lower jaw, to enter the dental foramen. Running along the canal in the lower jaw, it distributes branches to the molar and bicuspid teeth and to the gums, and at the mental foramen divides into two terminal branches, incisive and mental. The *incisive* branch is continued forward within the bone to the symphysis, supplying the canine and incisor teeth. The *mental* branch emerges from the jaw at the mental foramen, beneath the depressor anguli oris muscle, and divides into branches supplying the mucous membrane and skin of the lower lip. It communicates freely with the facial nerve. Before entering the inferior dental canal, the inferior dental nerve gives off the *mylo-hyoid* branch. This nerve pierces the internal lateral ligament, descends in a groove on the inner surface of the lower jaw to supply the mylo-hyoid muscle and anterior belly of the digastric.

The *lingual nerve* descends between the internal and external pterygoid muscles to the inner side of the inferior dental nerve. Below the border of the external pterygoid, it curves forward between the internal pterygoid and the ramus of the jaw, crosses obliquely over the superior constrictor of the pharynx between the stylo-glossus muscle and the submaxillary gland, to the side of the tongue, along which it runs, crossing Wharton's duct to reach the tip. It supplies branches to the mucous membrane of the mouth and gums, the sub-lingual gland, the papillæ and mucous membrane of the sides and tip of the tongue. It communicates with the submaxillary ganglion and hypo-glossal nerve. These branches form a plexus at the anterior margin of the hyoglossus muscle. While between the pterygoid muscles it communicates with the inferior dental nerve, and a little lower down it is joined by the chorda tympani of the facial. This nerve is continued downwards with the lingual to the submaxillary ganglion.

6. THE GANGLIA OF THE FIFTH NERVE.

In addition to the Gasserian ganglion already described, there are in intimate connection with the fifth nerve four other ganglia, viz. :

- I. The ophthalmic, or lenticular ganglion.
- II. The sphenopalatine, or Meckel's ganglion.
- III. The otic, or Arnold's ganglion.
- IV. The submaxillary ganglion.

(a) The Ophthalmic Ganglion.

The ophthalmic, ciliary, or lenticular ganglion is placed at the back of the orbit between the optic nerve and external rectus muscle, on the ophthalmic artery. It has three roots—sensory, motor, and sympathetic.

The *sensory* or *long root*, derived from the nasal nerve, joins the ganglion at its superior angle.

The *motor*, or *short root*, derived from the third nerve, joins the ganglion at its inferior angle.

The *sympathetic root*, derived from the carotid plexus, is generally blended with the long root, but may enter the ganglion separately.

The *branches of distribution* are the *short ciliary nerves*,

which arise from the anterior angles in two groups. The upper group consists of about four, the lower of five or six, filaments. They pierce the sclerotic around the optic nerve.

(b) The Spheno-Palatine Ganglion.

The spheno-palatine, or Meckel's ganglion, is the largest of the cranial ganglia, and is deeply placed in the spheno-maxillary fossa.

The *sensory root* is from the superior maxillary nerve, by means of the two spheno-palatine branches.

The *motor root* is derived through the Vidian nerve from the facial.

The *sympathetic root* is from the carotid plexus through the Vidian nerve.

The *branches of distribution* of the ganglion are divided into four sets, ascending, descending, internal and posterior.

The *ascending branches*, three or four, are distributed to the periosteum of the orbit. One of these branches sometimes joins the ophthalmic ganglion.

The *descending branches* are the anterior, middle, and posterior palatine nerves. The *anterior* or *great palatine nerve* passes from the ganglion, through the posterior palatine canal, and, emerging from the posterior palatine foramen, is distributed to the hard palate. It communicates with the naso-palatine nerve. While in the posterior palatine canal it gives off *inferior nasal* branches, distributed to the middle and inferior meatus of the nose. The *middle* or *external palatine* nerve (occasionally wanting) passes through one of the accessory palatine canals, and is distributed to the tonsil, soft palate and uvula. The *posterior* or *small palatine nerve* passes through the small posterior palatine canal, and supplies the levator palati and azygos uvulæ muscles, soft palate, tonsil, and uvula.

The *internal branches* are the superior nasal and naso-palatine. The *superior nasal nerves*, four or five in number, enter the nasal fossa by the spheno-palatine foramen, and are distributed to the mucous membrane of the superior meatus, and the superior and middle spongy bones. The *naso-palatine* nerve enters the nasal

fossa with the preceding, and, crossing the roof of the nose, enters the septum (to which it gives filaments) and passes downwards and forwards along the vomer through the naso-palatine canal and foramina of Scarpa (the right nerve being behind) to be distributed to the palate.

The *posterior* branches are the Vidian and the pterygo-palatine.

The *Vidian nerve* passes backwards through the Vidian canal, and sends some branches through the bone to the mucous membrane at the back of the roof of the nose (*upper posterior nasal branches*). At its exit from the Vidian canal it receives the *large deep petrosal nerve* from the carotid plexus. The continuation of the nerve enters the cranium through the foramen lacerum, and passes back in a groove on the petrous portion of the temporal bone, where it takes the name of *great superficial petrosal nerve*. Lastly, it is continued through the hiatus Fallopii to join the geniculate ganglion of the facial nerve.

The *pterygo-palatine nerve* is a small branch which passes backwards through the pterygo-palatine canal and is distributed to the mucous membrane of the Eustachian tube and neighbouring part of the pharynx.

(c) The Otic Ganglion.

The otic ganglion (Arnold's) is situated immediately below the foramen ovale, on the inner surface of the inferior maxillary nerve, and round the origin of the internal pterygoid nerve. Posteriorly it is in contact with the middle meningeal artery.

Roots.—The *sensory* and *motor* roots come from the fifth, through the branch of the inferior maxillary nerve to the internal pterygoid muscle. Its *sympathetic* root comes from the plexus on the middle meningeal artery. The otic ganglion is also joined by the small superficial petrosal nerve, and has branches of communication with the auriculo-temporal and chorda tympani nerves.

Distribution.—Two branches, to tensor tympani and tensor palati muscles respectively.

(d) The Submaxillary Ganglion.

This ganglion is situated above the deep portion of the submaxillary gland, near the posterior border of the mylo-hyoid muscle.

Roots :

Motor, from chorda tympani (branch of facial).

Sensory, two or three filaments from lingual nerve.

Sympathetic, from the plexus on the facial artery.

Branches of distribution.—Six or eight filaments, which supply the submaxillary gland, Wharton's duct, and the mucous membrane of the mouth.

7. THE SIXTH NERVE.

The sixth, or abducent nerve, supplies the external rectus muscle.

Superficial origin.—Several filaments from the upper constricted part of the pyramid close to the pons Varolii, and often from the lower border of the pons itself.

Deep origin.—From the floor of the fourth ventricle beneath the outer part of the fasciculus teres.

Course.—Piercing the dura mater, on the basilar process of the occipital bone, the nerve passes through a notch immediately below the posterior clinoid process, and enters the cavernous sinus. It then runs through the sinus lying on the outer side of the internal carotid artery to enter the orbit through the sphenoidal fissure, lying above the ophthalmic vein. It then passes between the heads of the external rectus and supplies that muscle on its ocular surface.

8. THE SEVENTH NERVE.

The seventh, or *facial*, is the motor nerve to all the muscles of the face, as well as to the platysma, buccinator, posterior belly of digastric, stylo-hyoid, lingualis and stapedius muscles, and to those of the external ear.

Superficial origin.—From the depression between pons and upper ends of olivary and restiform bodies.

Deep origin.—Floor of fourth ventricle, from a nucleus under outer part of fasciculus teres.

To its outer side lies the eighth nerve, and between

the two is a small fasciculus—the *pars intermedia*—which arises from the medulla and joins the facial nerve in the internal auditory meatus.

The seventh nerve passes outwards on the middle peduncle of the cerebellum and enters internal auditory meatus with auditory nerve, lying in that canal first to the inner side of the latter nerve and then in a groove upon it. It then enters the aqueductus Fallopii from its commencement in the internal meatus, and passes to its termination at the stylo-mastoid foramen. At the bend of the aqueduct the seventh nerve has upon it a gangli-form swelling, the *intumescencia gangliiformis* or *geniculate ganglion*, where it is joined by several nerves, as will be seen later. From the stylo-mastoid foramen the nerve passes forward, enters the parotid gland, crosses the external carotid artery, and divides opposite the ramus of the jaw into two primary trunks, *temporo-facial* and *cervico-facial*. This division, being like a bird's claw, is called the *pes anserinus*.

The following are the communications of the seventh nerve :

In internal auditory meatus 	} With auditory nerve.
In aqueductus Fallopii	{ With Meckel's ganglion by large petrosal nerve. With otic ganglion by small petrosal nerve. With sympathetic, on middle meningeal artery, by external petrosal nerve.
At exit from stylo-mastoid foramen ...	{ With vagus. ,, glosso-pharyngeal. ,, carotid plexus. ,, great auricular. ,, auriculo-temporal.
On the face 	{ With the three divisions of fifth nerve.

Distribution. — The branches of distribution are divided into three sets as follows :

(a) Branches given off within aqueductus Fallopii.

1. *Communicating* as above.
2. *Tympanic*.—A small filament to stapedius muscle.
3. *Chorda tympani*.—Given off just before the nerve leaves the stylo-mastoid foramen. It enters the tympanum through an opening, *iter chordæ posterius*, between the opening of the mastoid cells and the attachment of the membrana tympani. Crossing the tympanum between handle of malleus and long process of incus, it emerges through a foramen in the Glasserian fissure (*iter chordæ antierius*, or *canal of Huguier*). It then passes down between the two pterygoid muscles, joins the lingual nerve at an acute angle, and accompanies it to the submaxillary ganglion, of which it forms the motor root (see p. 128), finally terminating in the lingualis muscle.

(b) Branches given off at exit from stylo-mastoid foramen.

1. *Posterior auricular*.—Arises close to the foramen, ascends in front of mastoid process, where it communicates with auricular branch of vagus, the great auricular and small occipital, and divides into two branches, anterior and posterior. The anterior or *auricular* branch supplies the retrahens aurem and small muscles of the pinna. The posterior or occipital branch passes back along superior curved line of occipital bone and supplies occipito-frontalis muscle.

2. *Stylo-hyoid*.—A long, slender branch, passes inwards to the stylo-hyoid, and communicates with sympathetic on external carotid.

3. *Digastric*.—Arises by a common trunk with the last, supplies posterior belly of digastric, and communicates with glosso-pharyngeal nerve.

(c) Branches given off on face.

are grouped in two sets : 1. Temporo-facial, 2. Cervico-facial.

1. *Temporo-facial*, the larger of the two terminal divisions, communicates with the auriculo-temporal

nerve, and divides into (i.) Temporal, (ii.) Malar, and (iii.) Infra-orbital branches.

(i.) *Temporal branches*.—These cross the zygoma to the temporal region, supplying the *attrahens* and *attollens aures*, *orbicularis palpebrarum* and frontal portion of *occipito-frontalis* muscles and communicate with supra-orbital, auriculo-temporal, lachrymal, and temporal (of superior maxillary) nerves.

(ii.) *Malar Branches*.—Cross the malar bone to outer angle of orbit, supply *orbicularis palpebrarum* and *corrugator supercilii* muscles, and communicate with supra-orbital and *ramus subcutaneus malæ* nerves.

(iii.) *Infra-orbital Branches*.—Pass horizontally forwards in two sets. The *superficial* set supply superficial muscles of the face between lower margin of orbit and mouth, the *pyramidalis nasi* muscle and lower eyelid. The *deep* set supply *levator labii superioris* and *levator anguli oris*, passing beneath these muscles to communicate with the infra-orbital, infra-trochlear and nasal nerves to form the *infra-orbital plexus*.

2. *The cervico-facial* division passes through the parotid gland downwards and forwards, and opposite the angle of the lower jaw divides into (i.) Buccal, (ii.) Supra-maxillary, and (iii.) Infra-maxillary.

(i.) *Buccal Branches* cross the *masseter* muscle, and are distributed to *orbicularis oris* and *buccinator* muscles, communicating with *temporo-facial* division and the buccal branches of the inferior maxillary nerve.

(ii.) *Supra-maxillary Branches* pass forwards beneath *platysma* and *depressor anguli oris* to supply the muscles of the lower lip and chin, communicating with the mental branch of inferior dental nerve.

(iii.) *Infra-maxillary Branches* pass downwards and forwards under *platysma* to side of neck, over supra-hyoid region, and supply the *platysma*, communicating with the superficial cervical nerve.

9. THE EIGHTH NERVE.

The eighth, or *auditory*, is the special nerve of the sense of hearing.

Superficial Origin.—From between pons Varolii and restiform body outside seventh nerve.

Deep Origin.—By two roots, *upper*, from *upper auditory nucleus* beneath lateral angle of fourth ventricle, some fibres passing to cerebellum; *lower*, partly connected with *inner auditory nucleus* beneath auditory tubercle in floor of fourth ventricle, and partly connected with *auditory stricæ*, the central connection of which is uncertain.

Distribution.—Winding round the restiform body the nerve crosses the posterior border of the middle cerebellar peduncle separated from the facial nerve by the auditory artery, to the internal auditory meatus, at the bottom of which it divides into *cochlear* and *vestibular* branches, distributed to the cochlea, vestibule, and semicircular canals. In the meatus it communicates with the facial nerve. The *cochlear* branch divides at the base of the modiolus, passes up the canals therein, and then between the layers of the lamina spiralis ossea. Here the nerve filaments form a network which contains ganglion cells (*ganglion spirale*) and from which branches are given off which perforate the bottom of the sulcus spiralis and pass outwards to the organ of Corti. The *vestibular* division subdivides into three branches, superior, middle, and inferior. The *superior* gives off numerous filaments, which pass through the foramina in the posterior part of the bottom of the internal auditory meatus, enter the vestibule, and are distributed to the utricle and ampulla of superior and external semicircular canals. The *middle* gives off numerous filaments, which enter the vestibule through the foramina in the lower depression, corresponding to the fovea hemispherica, and are distributed to the saccule. The *inferior* passes through the foramen behind the foramina for the last nerve, and is distributed to the ampulla of the posterior semicircular canal.

10. THE NINTH NERVE.

The ninth, or *glosso-pharyngeal*, supplies sensation to pharynx, fauces, and tonsil, and is the special nerve of taste to the tongue.

Superficial Origin.—From groove between olivary and restiform bodies below seventh nerve.

Deep Origin from nucleus in floor of fourth ventricle beneath inferior fovea.

Course.—The nerve passes outwards across the flocculus, and leaves the skull by the jugular foramen enclosed in a separate sheath of dura mater, lying anteriorly to pneumogastric and spinal accessory nerves, and internally to jugular vein. It then passes forward between jugular vein and internal carotid artery to reach posterior border of stylo-pharyngeus. It then curves inwards, passing over stylo-pharyngeus and middle constrictor, and behind hyo-glossus muscle, to be distributed to tongue, pharynx, and tonsil.

In the jugular fossa the nerve presents two gangliform enlargements.

The *superior*, or *jugular ganglion* is small, involving only the posterior fibres of the nerve. The *inferior*, *petrous ganglion*, or *ganglion of Andersch*, is larger, involving the whole nerve, and is lodged in a depression in lower border of petrous portion of temporal bone. Its *branches of communication* are: (i.) One to auricular branch of pneumogastric. (ii.) One to upper ganglion of pneumogastric. (iii.) One to superior cervical sympathetic ganglion.

Below the ganglion it communicates with the facial.

Distribution.—These branches are divided into six sets.

(i.) *Tympanic*, or *Jacobson's nerve*, arises from petrous ganglion, and enters a small bony canal in petrous portion of temporal bone to reach the tympanum. It divides into six branches, three *communicating* with carotid plexus, great superficial petrosal nerve, and otic ganglion, and three *branches of distribution*, one to fenestra rotunda, one to fenestra ovalis, and one to lining membrane of Eustachian tube and tympanum. These branches lie in grooves on promontory, forming the *tympanic plexus*.

(ii.) *Carotid*.—These follow trunk of internal carotid

artery, and communicate with sympathetic and pharyngeal branch of vagus.

(iii.) *Muscular* to stylo-pharyngeus.

(iv.) *Pharyngeal*.—Three or four which join with pharyngeal branches of pneumogastric and sympathetic nerves opposite middle constrictor muscle, forming the *pharyngeal plexus*.

(v.) *Tonsillar*.—These form a plexus round base of tonsil (*circulus tonsillaris*), from which branches are given off to the fauces and soft palate which communicate with palatine nerves.

(vi.) *Lingual*.—Two, one going to circumvallate papillæ and mucous membrane of base of tongue, the other to papillæ and mucous membrane of side of tongue.

11. THE TENTH NERVE.

The tenth, *pneumogastric*, or *vagus* has the largest distribution of all the cranial nerves. It is a nerve of both sensation and motion.

Superficial Origin.—From medulla in a line with the glosso-pharyngeal.

Deep Origin.—From a nucleus in floor of fourth ventricle in the calamus scriptorius.

Course.—Passing outwards over flocculus to jugular foramen, the nerve leaves the skull, enclosed with spinal accessory nerve in a sheath derived from dura mater. Whilst in the jugular foramen the nerve presents a small ganglion, *superior, jugular, or ganglion of the root*. Just below the jugular fossa it has a larger ganglion, *inferior or ganglion of the trunk*. To the *superior* ganglion the accessory part of the accessory nerve is attached. After the nerve has left the skull, it passes down side of neck enclosed in carotid sheath, lying at first between internal carotid artery and internal jugular vein. At level of thyroid cartilage, it lies between common carotid artery and the vein, and continues in relation with these vessels to root of neck. Below this point the course of the nerve is different on each side. The *right* nerve enters chest by passing between subclavian artery and vein, and descends by side of trachea to back of root of lung, where it forms the *posterior*

pulmonary plexus. From the plexus the nerve proceeds in two cords along posterior aspect of œsophagus, at the lower part of which they reunite to be continued on to the posterior surface of stomach. The *left* nerve enters chest between left carotid and subclavian arteries, behind left innominate vein, crosses aortic arch, and descends to back of root of left lung. It is then continued downwards along œsophagus to anterior aspect of stomach.

From the ganglia the following *branches of communication* are given off: From the *superior ganglion* filaments to spinal accessory, superior cervical sympathetic ganglion, and inferior ganglion of glosso-pharyngeal. From the *inferior ganglia* filaments to hypo-glossal, superior cervical sympathetic ganglion, and loop between first and second cervical nerves.

Distribution.—By nine sets of branches.

(i.) *Auricular (Arnold's nerve)* given off in the jugular fossa, receives a communication from glosso-pharyngeal, and passes outwards to a small foramen on outer wall of jugular fossa. It thus reaches the descending part of aqueductus Fallopii, where it gives off two branches, one to the facial, and one to communicate with the auricular branch of that nerve. The continuation of the nerve supplies skin over back part of pinna.

(ii.) *Pharyngeal* arises from inferior ganglion, and after receiving a filament from accessory portion of spinal accessory nerve, passes behind internal carotid artery to upper border of middle constrictor, upon which muscle it joins the *pharyngeal plexus* formed between it, glosso-pharyngeal, external laryngeal, and sympathetic nerves and from which branches are distributed to the muscles and mucous membrane of pharynx, and to palato-glossus and palato-pharyngeus muscles.

(iii.) *Superior laryngeal* arises from inferior ganglion, and descends behind internal carotid artery to pass through thyro-hyoid membrane, with superior laryngeal artery, to supply mucous membrane of interior of larynx above true vocal cords, whilst behind the artery it gives off *external laryngeal nerve*, which supplies crico-thyroid muscle and sends a filament to join the pharyngeal plexus.

(iv.) *Cardiac* branches, in two sets, cervical and thoracic. *The cervical*: two or three arise from cervical

portion of the nerve, the largest branch being given off just before it enters the chest. On the right side this branch (*inferior cardiac nerve*) descends by side of innominate artery to join deep cardiac plexus. On the left side it passes in front of aortic arch to join superficial cardiac plexus. The *superior cardiac nerve* is small, communicates with cardiac branches of sympathetic and goes to great cardiac plexus. The *thoracic cardiac nerves* on the right side arise from trunk of pneumogastric, and on the left are given off from recurrent laryngeal nerve. In each instance they join the deep cardiac plexus.

(v.) *Inferior or recurrent laryngeal nerve* arises, on the right side in front of subclavian artery, winding round that vessel from before backwards. It then ascends to side of trachea, passing behind common carotid and inferior thyroid arteries. On the left side the nerve curves round the aortic arch and ascends to trachea. Each nerve ascends in the groove between trachea and œsophagus and passes under lower border of inferior constrictor muscle to reach the larynx, to all the muscles of which it is distributed, except the crico-thyroid.

(vi.) *Anterior pulmonary* branches are two or three in number. With branches from the cardiac plexuses they form the *anterior pulmonary plexus*, and are distributed to anterior aspect of root of lung. The *posterior pulmonary* branches join the *posterior pulmonary plexus* and are distributed to posterior aspect of root of lung. The branches of these plexuses accompany the air tubes through the lung substance.

(vii.) *Œsophageal* branches, given off above and below pulmonary branches. They form a plexus with the branches of the opposite nerve round the œsophagus (*plexus gulæ*).

(viii.) *Gastric* branches are the terminal filaments of the nerve. The left nerve supplies anterior aspect of stomach, the right the posterior. The right communicates with the cœliac and splenic plexuses, the left with the left hepatic plexus.

12. THE ELEVENTH NERVE.

The eleventh or *spinal accessory* nerve consists of two parts, *spinal* and *accessory*.

Superficial Origin.—The *accessory* is small and continues the line of the ninth and tenth nerves along medulla as low as first cervical nerve. The *spinal*, firm and round, arises by fine filaments from lateral column of cord as low as sixth cervical nerve.

Deep Origin.—Both parts have been traced inwards to an elongated column of cells reaching from lower third of olivary body to level of fifth cervical spinal nerve, and situated in the spinal part of its extent in outer part of anterior horn of gray matter, in medulla behind and to outer side of nucleus of twelfth nerve.

Course and Distribution.—The *accessory* portion joins ganglion of root of vagus and is continued over ganglion of trunk to be distributed with pharyngeal and superior laryngeal branches, some filaments passing down vagus to join recurrent laryngeal. The *spinal* portion passes out through jugular foramen in same sheath of dura mater as vagus, but separated from that nerve by the arachnoid. It then passes backwards behind (or in front) of internal jugular vein behind digastric and stylo-hyoid to upper part of sterno-mastoid. Piercing that muscle it passes across the posterior triangle, communicating with second and third cervical nerves, and ends in trapezius, under which it communicates with third and fourth cervical nerves.

13. THE TWELFTH NERVE.

The twelfth or *hypo-glossal* nerve is motor to the tongue.

Superficial Origin.—In front of medulla a long groove between pyramid and olivary body in a line with anterior roots of spinal nerves.

Deep Origin.—From a nucleus in front of central canal below, and extending upwards into lower part of fasciculus teres in fourth ventricle.

Course.—Passing forward through anterior condyloid foramen, the nerve goes downwards and forwards between internal carotid artery and internal jugular

vein until it becomes parallel with angle of lower jaw. It then curves forward round occipital artery, the stylo-mastoid branch of which hooks over it, crosses the external carotid and passes beneath the mylo-hyoid, between it and the hyo-glossus. It is then continued into genio-hyo-glossus as far as tip of tongue, to the substance of which it gives branches. In its course it communicates with pneumogastric, sympathetic, first and second cervical, and lingual nerves.

The branches of distribution are :

- (i.) *Meningeal*.—Filaments to dura mater of posterior cranial fossa, given off as the nerve leaves the anterior condyloid foramen.
- (ii.) *Descendens cervicis*.—A long slender branch, given off just as the hypo-glossal loops round occipital artery. It descends on sheath of carotid vessels, and just below middle of neck forms a loop with the *communicantes cervicis* nerves from second and third cervical. From this loop are given off branches to supply sterno-hyoid, sterno-thyroid, and both bellies of omo-hyoid.
- (iii.) *Thyro-hyoid*, a small branch given off near posterior border of hyo-glossus muscle. It supplies thyro-hyoid muscle.
- (iv.) *Muscular*.—Several branches given off beneath mylo-hyoid to supply stylo-glossus, hyo-glossus, genio-hyoid, and genio-hyo-glossus muscles.

B.—The Spinal Nerves.

The spinal nerves are so called because they arise from the spinal cord, and leave the spinal canal by the inter-vertebral foramina. They number thirty-one pairs, arranged in the following groups corresponding to the regions through which they pass :

Cervical	...	...	...	8 pairs.
Dorsal	...	...	...	12 „
Lumbar	...	...	...	5 „
Sacral	...	...	...	5 „
Coccygeal	...	...	...	1 pair.

It will be noticed that each group, with the exception of the cervical and coccygeal, corresponds in number with the vertebræ in that region.

Each spinal nerve arises by two roots, an *anterior motor* and a *posterior sensory*. The former arise on the antero-lateral columns of the cord, gradually approaching the anterior median fissure as they descend. Their fibres pass inwards to the anterior horn of gray matter, there diverging in three directions, viz., *inwards* across the anterior commissure to the large cells in the anterior cornu of the opposite side, some ending in the mesial group of cells in the anterior column of the same side; *outwards* to the cells in the lateral part of the anterior column, some entering the lateral column of the same cells, turning upwards as longitudinal fibres; *backwards* to the cells at the base of the posterior horn of gray matter.

The *posterior roots* arise at the postero-lateral fissure. They enter the posterior gray horn, either through the substantia gelatinosa of Rolando, or first passing through the white matter of the posterior column and winding round in front of the caput cornu. The latter blend with the column of Lockhart Clarke; the former turn upwards and downwards to become continuous with the nerve-plexus in the central portion of the gray matter.

Having left the cord in two bundles, the posterior roots have each a ganglion (*ganglion of the posterior root*) developed upon them, which the two bundles join separately. The posterior root of the first cervical nerve frequently has no ganglion. Beyond these ganglia the posterior roots join with their corresponding anterior roots to form a *mixed nerve*. The trunks thus formed pass through the intervertebral foramina and divide into *anterior* and *posterior primary divisions*.

The roots of the spinal nerves run obliquely from their origins to the exit at the intervertebral foramina. This obliquity varies in the different regions of the spine, being greater in the lower than in the upper part.

1. THE CERVICAL NERVES.

The cervical nerves are eight in number, being named according to the vertebra *above* which they leave the spinal canal, except the eighth, which leaves below the seventh cervical vertebra.

(a) Posterior Divisions.

Each posterior division, except that of the first nerve, divides into an *external* and an *internal* branch.

The posterior division of the *first cervical nerve* (*sub-occipital*), larger than the anterior division, leaves the spinal canal between the occipital bone and posterior arch of the atlas, behind the vertebral artery. Entering the sub-occipital triangle, it supplies the recti, obliqui, and complexus muscles. From the branch of the inferior oblique a filament passes to the second cervical nerve. The nerve also communicates with the great and small cervical nerves, and gives off a cutaneous branch which accompanies the occipital artery.

The posterior division of the *second cervical nerve*, larger than the anterior division and than the posterior divisions of the other cervical nerves, leaves the spinal canal between the atlas and axis below the inferior oblique muscle (which it supplies), and receives a communicating branch from the first cervical. It divides into *internal* and *external* branches. The *internal* branch, or *great occipital nerve*, ascends inwards between the inferior oblique and complexus muscles, piercing the latter and the trapezius near the skull. Joined by a branch from the third nerve, it ascends on the back of the head with the occipital artery and divides into two branches, which supply the skin as far forwards as the vertex, and communicates with the small occipital nerve. It gives off an *auricular* branch to the back of the ear and supplies the complexus muscle. The outer branch supplies complexus, splenius and trachelo-mastoid muscles.

The posterior division of the *third cervical nerve*, before dividing into external and internal branches, gives off a *cutaneous* branch, which pierces the trapezius and supplies the skin on the lower and back part of the head, lying to the inner side of and communicating with the great occipital nerve. The *internal* branch passes between the semispinalis and complexus, pierces the splenius and trapezius and supplies the skin over the latter. The *external* branch supplies splenius, complexus, and trachelo-mastoid muscles.

The posterior primary division of the first, and the

internal branches of those of the second and third nerves, often communicate beneath the complexus (*posterior cervical plexus*).

The posterior divisions of the *fourth, fifth, sixth, seventh, and eighth cervical nerves* pass backwards behind the posterior intertransverse muscles and divide into external and internal branches. The *internal* branches of the fourth and fifth pass between the semispinalis and complexus muscles to the spinous processes, where they pierce the splenius and trapezius, and supply the skin over the latter muscle. Those of the sixth, seventh, and eighth are under the semispinalis, which they supply, with the interspinales, multifidus spinæ, and complexus. The *external* branches supply the cervicalis ascendens, transversalis colli and trachelo-mastoid muscles.

(b) Anterior Divisions.

The first four cervical nerves form the *cervical plexus*. The last four, with the anterior division of the first dorsal, form the *brachial plexus*.

2. THE CERVICAL PLEXUS.

This plexus, formed by the anterior divisions of the first four cervical nerves, lies opposite the upper four cervical vertebræ upon the levator anguli scapulæ and scalenus medius muscles and under the sterno-mastoid. It is formed by communicating branches between the four nerves, and is a *loop plexus*.*

The branches of the cervical plexus are divisible into two groups, *superficial* and *deep*, each of which is subdivided into two sub-groups, thus :

Superficial	{	Ascending	{	Superficial cervical.
				Great auricular.
	{	Descending supra-clavicular	{	Small occipital.
				Sternal.
				Clavicular.
				Acromial.

* It will be seen that the four great plexuses are alternate *loop* and *cord* plexuses ; the two former being the cervical and lumbar, the two latter the brachial and sciatic.

Deep	{	Internal	{	Communicating.
			{	Muscular.
			{	Communicantes cervicis.
			{	Phrenic.
	{	External	{	Communicating.
			{	Muscular.

(a) Superficial Branches.

1. *Superficial cervical* arises from the second and third nerves, turns round middle of posterior border of sterno-mastoid, crosses that muscle under external jugular vein, perforates deep fascia under platysma, and divides into *ascending* and *descending* branches. The former gives a branch to accompany external jugular vein, and passes up to submaxillary region, where it subdivides to supply the platysma and skin of upper half of neck as high as the chin, and forms a plexus with the facial nerve. The descending branch pierces platysma and supplies skin of neck as far down as the sternum.

2. *Great auricular* arises from second and third nerves, winds round posterior border of sterno-mastoid, perforates deep fascia and descends under platysma to the parotid gland, where it divides into the following branches: *facial*, to supply skin over parotid region and to pierce parotid gland to communicate with facial nerve; *posterior* or *auricular*, to supply skin of back of pinna and communicate with auricular branches of vagus and facial nerves; *mastoid*, which communicates with small occipital and posterior auricular (of facial) nerves, and supplies skin behind ear.

3. *Small occipital* (sometimes double) arises from second cervical nerve, winds round posterior border of sterno-mastoid above the last nerve, and goes nearly vertically along posterior border of the muscle to back part of side of head. Perforating deep fascia, it passes up along side of head behind the ear, supplies the skin, and communicates with great occipital, great auricular and posterior auricular (of facial) nerves. It gives off an *auricular* branch to skin of upper and back part of pinna, which communicates with mastoid branch of great auricular nerve (this branch may arise from the great occipital).

4. *Supra-clavicular* arise from third and fourth cervical and emerge from under posterior border of sternomastoid. They descend between that muscle and trapezius, dividing into *sternal*, *clavicular*, and *acromial* branches, which supply the skin over those regions, from the middle line of the chest to the upper and back part of the shoulder.

(b) Deep Branches.

1. *Internal*.—These are *communicating*, from loop between first and second nerves with vagus, hypoglossal, and sympathetic nerves; *muscular*, from the first nerve and the loop between it and the second, to the anterior recti and rectus capitis lateralis; *communicantes cervicis*, two filaments from second and third nerves, which pass down on outer side of internal jugular vein, cross that vessel and join the descending cervical branch of the hypoglossal nerve just below the middle of the neck in front of carotid sheath.

The largest of the internal series is the *phrenic* or *internal respiratory of Bell*. It arises from third and fourth cervical nerves, receiving a communicating branch from the fifth nerve. Descending across the scalenus anticus muscle to the root of the neck, it passes over the first part of subclavian artery (between it and the vein) and crosses the internal mammary artery near its origin. In the chest it descends in front of the root of the lung by the side of the pericardium to the diaphragm, where it divides into branches which pierce that muscle to supply its under surface. The *right* nerve is shorter, deeper, and more vertical than the left, and lies on the outer side of the right innominate vein and superior vena cava. The *left* nerve, owing to the inclination of the heart to that side, is longer. It crosses the aortic arch to reach the root of the lung. Each nerve supplies pericardium, pleura, and peritoneum, and communicates with sympathetic and nerve to subclavius muscle. The *right* nerve gives branches to a small ganglion with the phrenic branches of solar plexus and from this ganglion filaments pass to the supra-renal body, inferior vena cava and hepatic plexus. The *left* nerve gives branches to the phrenic plexus without the intervention of any ganglion.

2. *External series*.—These are *communicating* with spinal accessory nerve (in substance of sterno-mastoid, in occipital triangle, and under trapezius), and *muscular* to sterno-mastoid (from second), trapezius, and levator anguli scapulæ (from third and fourth), and scalenus medius (from third, or fourth, or both).

3. THE BRACHIAL PLEXUS.

This plexus is formed by the anterior primary branches of the last four cervical and first dorsal nerves, a small fasciculus joining it from the fourth cervical. It extends from the lower part of the side of the neck to the axilla. It is a *cord* plexus, its arrangement varying somewhat. The following table will, however, show its most constant formation :

Cervical	{ Fifth	{ outer	each of these trunks divides into two branches.	{	1. Anterior.
	{ Sixth	{ trunk			2. Posterior.
	{ Seventh	{ middle			3. Anterior.
	{ Eighth	{ trunk			4. Posterior.
Dorsal	{ First	{ inner		{	5. Anterior.
		{ trunk			6. Posterior.

1 and 3 join to form external cord.

2, 4, 6, „ „ posterior cord.

5 forms internal cord.

The blending into three trunks takes place on the scalenus medius outside the external border of the scalenus anticus. The division of the trunks into anterior and posterior branches occurs as the plexus passes beneath the clavicle, and the final arrangement into external, internal, and posterior cords is opposite the second part of the axillary artery, the cords being named from their relative positions in regard to that vessel. The *branches* of the brachial plexus are divided into two groups as they arise above or below the clavicle.

(a) Branches above the Clavicle.

1. *Communicating* with phrenic, from fifth cervical nerve.

2. *Muscular*, to *scaleni* and longus colli muscles, one from each of the lower four cervical nerves.

3. *Rhomboid*, from fifth nerve to supply rhomboid muscles, piercing middle scalene, and passing under levator anguli scapulæ muscles.

4. *Subclavian* nerve, from fifth nerve, passing over subclavian artery to supply subclavius muscle.

5. *Posterior (long) thoracic*, or *external respiratory of Bell*, arising by two roots from fifth and sixth cervical nerves (sometimes also from seventh), passes down behind plexus and axillary vessels on outer surface of serratus magnus to its lower border and supplies that muscle.

6. *Suprascapular*, arising from trunk formed by fifth and sixth nerves, passes out under trapezius to go through suprascapular notch into supra-spinous fossa. Here it supplies supra-spinatus and shoulder-joint, and curves round scapular spine to infra-spinous fossa, where it ends in infra-spinatus muscle, and gives branches to scapula and shoulder-joint.

(b) Branches below the Clavicle.

I. *From external cord*:

1. *External anterior thoracic* (consists of fibres from 5th, 6th, and 7th cervical nerves) passes inwards across axillary vessels, pierces costa-coracoid membrane, supplies pectoralis major muscle and communicates with internal anterior thoracic.

2. *Outer head of median*, passes over axillary artery to join inner head (*quod vide*).

3. *Musculo-cutaneous*, *external cutaneous*, or *nervus perforans Casserii*. (Fibres from 5th, 6th, and 7th nerves.)—Arises opposite lower border of pectoralis minor. Perforates coraco-brachialis and descends obliquely between biceps and brachialis anticus (supplying all three muscles) to outer side of arm, then winds round tendon of biceps, pierces deep fascia, and becomes cutaneous. In the arm it supplies also the bone and elbow-joint. The forearm it supplies by *anterior* and *posterior* branches, the former going along radial border to wrist (supplying outer half of anterior surface), and ball of thumb, the latter passing along back part of radial side to wrist, and supplying skin of lower third of back of forearm.

II. *From Internal Cord :*

1. *Internal anterior thoracic.* (Fibres from 8th cervical and 1st dorsal.)—Passes up between axillary artery and vein to supply pectoralis minor, some branches piercing that muscle to supply pectoralis major.

2. *Internal cutaneous.* (Fibres from 8th cervical and 1st dorsal.)—Passes down on inner side, pierces deep fascia with basilic vein at middle of arm, and divides into *anterior* and *posterior* cutaneous branches. The former passes over or under median basilic vein and supplies ulnar side of forearm as far as wrist. The latter passes behind internal condyle and supplies posterior surface of ulnar side of forearm as far as wrist.

3. *Lesser internal cutaneous (nerve of Wrisberg).* (Fibres from 1st dorsal.)—Passes first behind, then internal to axillary vein and communicates with intercosto-humeral nerve. Then goes along inner side of brachial artery to middle of arm, there pierces deep fascia and supplies skin of back of lower third of arm as far as elbow.

4. *Inner head of Median.*—This joins outer head from outer cord (the two embracing axillary artery) to form *median nerve* (fibres from 6th, 7th, and 8th cervical and 1st dorsal). This passes down on brachial artery, crossing from its outer to its inner side (in front or behind) at middle of arm, lies on brachialis anticus between artery and tendon of biceps at triangle in front of elbow. In the forearm it passes between heads of pronator radii teres to lie (with median artery) between flexor sublimis and flexor profundus digitorum to within two inches of anterior annular ligament, where it lies between the tendons of flexor sublimis digitorum and flexor carpi radialis. It then passes under annular ligament to hand. It gives the following branches :

(a) *In arm :* None.

(b) *In forearm :*

- i. *Muscular*, to all superficial muscles of forearm, except flexor carpi ulnaris.
- ii. *Anterior interosseous*, with anterior interosseous artery to supply all deep muscles save half flexor profundus digitorum, terminating in pronator quadratus.

- iii. *Palmar cutaneous*, which pierces fascia above annular ligament to supply (by two branches) skin over ball of thumb and palm of hand.

(c) *In palm of hand*.—Here the median nerve lies between palmar fascia and flexor tendons and divides into two branches :

- i. *External*, which gives a *muscular* branch to abductor, opponens, and outer head of flexor brevis pollicis muscles, and *digital* branches, five in number. The *first* and *second* supply the thumb, the *third* supplies radial side of index-finger and first lumbrical muscle, the *fourth* supplies adjacent sides of index and middle fingers and second lumbrical muscle, and the *fifth* supplies adjacent sides of middle and ring fingers, communicating with ulnar nerve. These nerves are superficial to the digital arteries at the sides of the fingers.

5. *Ulnar*. (Fibres from 8th cervical and 1st dorsal).—Lies to inner side of axillary and brachial arteries to middle of arm ; it then runs obliquely to pierce internal intermuscular septum and enter groove between olecranon and internal condyle, with inferior profunda artery. It next passes to forearm between heads of flexor carpi ulnaris, descending under that muscle, and on flexor profundus digitorum to wrist, where it crosses annular ligament on outer side of pisiform bone to divide into two terminal branches. In the lower two-thirds of the forearm the ulnar artery lies to its outer side. The ulnar nerve gives the following *branches* :

(a) *In forearm* :

- i. *Articular*, to elbow.
- ii. *Muscular*, to flexor carpi ulnaris, and inner half of flexor profundus digitorum.
- iii. *Cutaneous*.—Arises about middle of forearm and divides into two branches, one of which pierces fascia near wrist, while the other (*palmar cutaneous*) lies on ulnar artery and ends in skin of palm of hand.
- iv. *Dorsal cutaneous*, arises two inches above wrist, passes back under flexor carpi ulnaris, pierces fascia, and runs along ulnar side of hand to

supply little and ulnar side of ring-fingers and communicate with radial nerve.

v. *Articular*, to wrist.

(b) *In hand* :

- i. *Superficial palmar*, supplies palmaris brevis and skin of inner side of hand, ending in two *digital* branches, one to ulnar side of little finger, the other to adjacent sides of little and ring fingers, and communicating with median nerve.
- ii. *Deep palmar*, passes between abductor and flexor brevis minimi digiti, grooving convex side of back of unciform bone (Anderson), and follows deep palmar arch under flexor tendons. It supplies muscles of little finger and two branches to each interosseous space, one for dorsal and one for palmar interosseous muscles, the branch to the second and third palmar interossei supplying inner two lumbrical muscles. It terminates by supplying adductor obliquus, adductor transversus, and inner head of flexor brevis pollicis muscles.

III. *From Posterior Cord* :

1. *Subscapular*. (Fibres from 5th, 6th, 7th, and 8th nerves.)—Three in number.

(a) *Upper*, to subscapularis muscle.

(b) *Middle*, or *long*, to subscapularis and latissimus dorsi muscles. This nerve accompanies subscapular artery.

(c) *Lower*, to subscapularis and teres major muscles.

2. *Circumflex*. (Fibres from 5th, 6th, 7th, and 8th nerves).—Arises in common with musculo-spiral nerve. Winds with posterior circumflex artery through quadrilateral space at upper part of arm (see page 83), supplies shoulder-joint, and divides into two branches :

(a) *Upper*, which winds round surgical neck of humerus under deltoid with posterior circumflex vessels, to anterior border of that muscle, supplying it and skin over its lower part.

(b) *Lower*, to teres major (the filament has a gangliform enlargement on it) and deltoid muscles and to skin over posterior surface of latter.

3. *Musculo-spiral*. (Fibres from 6th, 7th, and 8th cervical and 1st dorsal.)—Placed first behind axillary and brachial arteries, it winds round humerus with superior profunda artery in musculo-spiral groove, between inner and outer heads of triceps muscle. It then goes down between brachialis anticus and supinator longus muscles to front of outer condyle and divides into radial and posterior interosseous nerves. Its branches are :

- i. *Muscular*, to triceps, anconeus, supinator longus, extensor carpi radialis longior and brachialis anticus.
- ii. *Cutaneous*.—Three, one *internal* and two *external*. The former supplies skin on back of arm from axilla nearly to olecranon. The upper external branch supplies skin of lower half of front of arm, the lower external passes along outer side of arm and elbow and back of radial side of forearm to wrist, supplying skin of those parts.
- iii. *Radial*, lies first under supinator longus outside radial artery ; it leaves the vessel three inches above wrist, passes under tendon of supinator longus, pierces fascia and divides into two branches, *outer* to radial side and ball of thumb, and *inner*, which forms an arch across back of hand with dorsal cutaneous branch of ulnar, and divides into three *digital* nerves, the first going to adjacent sides of thumb and index finger, the second to adjacent sides of index and middle fingers, and the third to adjacent sides of middle and ring fingers.
- iv. *Posterior interosseous*.—Winds to back of forearm in substance of supinator brevis muscle and passes between superficial and deep muscles to middle of forearm. It then passes on interosseous membrane under extensor secundi interodii pollicis to back of carpus to which it is distributed, its termination presenting a gangli-form enlargement. It supplies all the posterior muscles except anconeus, supinator longus, and extensor carpi radialis longior.

4. THE DORSAL NERVES.

There are twelve dorsal nerves on each side, named from the vertebra *beneath* which they issue.

(a) Posterior Divisions.

These pass backwards between transverse processes and divide into *external* and *internal* branches.

The *external* branches increase in size from above downwards. They pass through longissimus dorsi to interval between it and sacro-lumbalis, supplying them and levatores costarum. The lower five or six give *cutaneous* branches, which pierce serratus posticus inferior and latissimus dorsi in a line with costal angles.

The *internal* pass to interval between multifidus spinæ and semispinalis muscles, supplying them. The upper six branches continue through rhomboidei and trapezius to become cutaneous at sides of spinous processes.

(b) Anterior Divisions.

These (*intercostal nerves*) are twelve on each side.

The *first* divides into two branches, the larger one of which helps to form brachial plexus ; the other runs in first intercostal space, terminating on front of chest as *first anterior cutaneous nerve* of thorax. It has no lateral cutaneous offset.

The *six upper dorsal nerves* (including the smaller branch of the first, just described) pass forwards in six upper intercostal spaces, below intercostal arteries, becoming cutaneous at side of sternum to form *anterior cutaneous nerves* of thorax. They supply intercostal, levatores costarum, serratus posticus superior, and triangularis sterni muscles, and lie in inferior costal grooves, first between pleura and external intercostal muscles, then between two intercostal muscles, finally piercing internal intercostal muscle and lying between it and pleura. Each nerve, except the first, gives a *lateral cutaneous* offset at mid-axillary line, which, except that of the second, divides into *anterior* and *posterior* branches. The former supply skin of chest and mamma and digitations of external

oblique muscle of abdomen, the latter supply skin over latissimus dorsi and scapula. The lateral cutaneous branch of the second nerve is called *intercosto-humeral* : it crosses axilla to inner side of arm, communicating with lesser internal cutaneous, and supplies upper half of inner and back part of arm.

The lower six dorsal nerves. These are continued from their intercostal spaces to abdominal wall ; the twelfth, as it lies below last rib, having its whole course in the abdominal wall. With the exception of the last, they have a similar arrangement to the upper six nerves until they pass under costal cartilages to get between internal oblique and transversalis muscles, and perforate sheath of rectus abdominis, becoming cutaneous near linea alba as *anterior cutaneous nerves of abdomen*. They supply intercostal, serratus posticus inferior, and abdominal muscles.

The *last dorsal* nerve is the largest of all the dorsal nerves. It communicates with ilio-hypogastric nerve and with first lumbar nerve by a slender *dorsi-lumbar nerve*, which descends in substance of quadratus lumborum muscle. Its *lateral cutaneous* offset is large, and does not divide. It perforates internal and external oblique muscles, passes down over iliac crest to supply skin in front of hip as far as great trochanter.

5. THE LUMBAR NERVES.

There are five lumbar nerves on each side, named from the vertebræ *beneath* which they emerge.

(a) Posterior Divisions.

These diminish in size from above downwards, passing back between transverse processes and dividing into *external* and *internal* branches. The former supply erector spinæ and intertransverse muscles, the upper three becoming cutaneous to supply skin over buttock. The internal branches supply multifidus spinæ and interspinales muscles.

(b) Anterior Divisions.

These accompany lumbar arteries under psoas. From behind that muscle they pass obliquely out, supplying it

and quadratus lumborum. The upper four form a *loop* plexus, the *lumbar plexus*. The fifth joins a branch of the fourth, descends over base of sacrum to join anterior division of first sacral nerve to help form the sacral plexus.

6. THE LUMBAR PLEXUS.

This plexus is formed by anterior divisions of first four lumbar nerves, the first being joined by the *dorsilumbar nerve* (*vide suprâ*). It lies in substance of psoas muscle in front of lumbar transverse processes.

The following table explains the formation of the plexus :

First lumbar	{ ilio-hypogastric. { ilio-inguinal. { communicating to { which forms part of second . . . { genito-crural.
Second lumbar	{ rest of genito-crural. { communicating to { forming parts of ex- third . . . { ternal cutaneous, { anterior crural and { obturator.
Third lumbar	{ rest of external cutaneous. { rest of anterior crural. { part of obturator. { part of accessory obturator (when pre- sent). { communicating to fourth.
Fourth lumbar	{ rest of anterior crural. { rest of obturator. { rest of accessory obturator (when pre- sent). { communicating to fifth.

Branches :

1. *Ilio-hypogastric* (*superior musculo-cutaneous*) arises from first lumbar nerve. Emerging from upper part of outer border of psoas, it crosses quadratus lumborum to iliac crest. It then perforates transversalis and divides into iliac and hypogastric branches. The *iliac* branch pierces internal and external oblique, and supplies skin over buttock behind lateral cutaneous offset of last

dorsal nerve. The *hypogastric* branch passes on between internal oblique and transversalis muscles, then pierces oblique and, near middle line, external oblique above external abdominal ring to supply skin over hypogastric region.

2. *Ilio-inguinal* (*inferior musculo-cutaneous*) arises from first lumbar nerve. Emerging from outer border of psoas below ilio-hypogastric, it passes over quadratus lumborum and iliacus, pierces transversalis, and goes forwards under internal oblique to pass with spermatic cord through external abdominal ring and supply skin over upper and inner part of thigh and scrotum (or labium). It often also supplies skin of side of penis.

3. *Genito-crural*.—Arises from first and second lumbar nerves, pierces psoas, and divides into genital and crural branches. The *genital* branch goes on external iliac artery, pierces fascia transversalis (or goes through internal abdominal ring), passes on spermatic cord to scrotum to supply cremaster muscle (or becomes lost on round ligament of female). The *crural* branch passes under Poupart's ligament to thigh, entering femoral sheath lying superficial and external to femoral artery. Piercing anterior layer of sheath and fascia lata, it supplies skin of front of thigh for upper half.

4. *External cutaneous*.—From second and third lumbar nerves. Emerges from middle of outer border of psoas, crosses iliacus to notch under anterior superior iliac spine, and, passing under Poupart's ligament, divides into *anterior* and *posterior* branches. The former passes down under fascia lata, piercing it a hand's breadth below Poupart's ligament to supply skin on front and outer part of thigh as far as knee. The posterior branch pierces fascia lata and supplies outer and back part of thigh from iliac crest to middle of thigh.

5. *Obturator* arises from second, third and fourth lumbar nerves, goes down in psoas to brim of pelvis, where it pierces the muscle at its inner border and runs along lateral wall of pelvis, above obturator vessels, to upper part of obturator membrane, where it enters thigh and divides into anterior and posterior branches. The *anterior* branch passes in front of adductor brevis and under pectineus and adductor longus, forming with internal cutaneous and internal saphenous nerves the

mid-femoral plexus, at lower border of long adductor. It then runs on femoral artery, on which it is distributed. It gives branches to hip joint, pectineus, adductor longus and gracilis muscles, and sometimes to adductor brevis and pectineus. Occasionally also it gives a cutaneous branch to inner side of leg as far as middle. The *posterior* branch pierces obturator externus, supplying it, passes behind adductor brevis on front of adductor magnus, and ends by passing with popliteal artery to supply the knee. It supplies adductors magnus and brevis.

6. *Accessory obturator* (occasionally absent) arises from third and fourth nerves or from obturator nerve, passes along inner border of psoas, crosses pubes, and goes underneath pectineus to supply that muscle and the hip joint.

7. *Anterior crural*, the largest branch, arises from second, third and fourth nerves, and passes through psoas, to leave by its outer border. Then, passing between psoas and iliacus under Poupart's ligament into thigh, it divides into two divisions, anterior and posterior. Its branches are :

- (a) *Inside pelvis*.—To iliacus and femoral artery.
- (b) *Outside pelvis*.

(a) From Anterior Division.

1. *Middle cutaneous*.—Pierces fascia lata (sometimes also sartorius) three inches below Poupart's ligament, and divides into two branches to skin of front of thigh as low as front of knee, taking part in the præpatellar plexus.

2. *Internal cutaneous*.—Passes across femoral sheath and divides into two branches. The *anterior* branch pierces fascia lata at lower third of thigh, and again divides to supply skin as low as inner side of knee, and to take part in præpatellar plexus. The *posterior* branch passes along inner border of sartorius to knee, where it pierces fascia lata and supplies the skin. It then passes down inner side of leg, supplying skin thereof. This nerve, or the middle cutaneous, supplies sartorius.

(b) From Posterior Division.

1. *Internal*, or *long saphenous*, approaches femoral artery at crossing of sartorius, and lies on its outer side in Hunter's canal to opening in adductor magnus. Here it gives off a *patellar* branch, which pierces sartorius and fascia, and communicates with external and internal cutaneous nerves to form the *præpatellar plexus*. The long saphenous then passes along inner side of leg, supplying it, and dividing at the lower third into two branches, one to supply skin as far as inner malleolus, the other the skin of inner side of foot as far as great toe. In the thigh the nerve helps to form the *mid-femoral plexus*.

2. *Muscular*, to pectineus and all muscles in front of thigh, except tensor vaginae femoris and sartorius.

3. *Articular*, two to the knee-joint, one coming from nerve to vastus externus, and one from nerve to vastus internus.

7. THE SACRAL AND COCCYGEAL NERVES.

There are five *sacral* and one *coccygeal* nerves. The former leave sacral canal through sacral foramina; the coccygeal nerve appears between the sacrum and coccyx.

(a) Posterior Divisions.

Sacral.—The posterior divisions of the sacral nerves are small, and emerge (except the last) by the posterior sacral foramina. The *upper three* lie under multifidus spinæ, and divide into two branches. The *internal* branches are small, and supply multifidus spinæ. The *external* ones join with one another and last lumbar and fourth sacral nerves by loops. They pass out on outer surface of great sacro-sciatic ligament, and form a second series of loops under gluteus maximus; three *cutaneous* branches pierce that muscle and supply the skin. The *lower two* sacral nerves do not divide, but communicate by loops with each other and coccygeal nerve.

Coccygeal nerve divides into anterior and posterior divisions in spinal canal. The *posterior* is lost on the back of the coccyx.

(b) Anterior Divisions.

The *upper four* emerge by the anterior sacral foramina; the *fifth* curves forwards between sacrum and coccyx. The *fourth*, after sending a branch to sacral plexus, divides into *visceral* to rectum and bladder (and vagina and uterus in female), and *muscular* to levator ani, coccygeus, and sphincter ani. From the latter *cutaneous* twigs are given, one of which perforates great sacro-sciatic ligament and winds round lower border of gluteus maximus. The *fifth* pierces coccygeus and descends thereon to tip of coccyx, where it again pierces the muscle to supply the skin. The anterior division of *coccygeal nerve* escapes at end of sacral canal, pierces coccygeus twice, and supplies skin over back and sides of coccyx.

8. THE SACRAL PLEXUS.

The *sacral plexus* is a *cord plexus*, and is formed by the *lumbo-sacral cord* (fifth lumbar and branch of fourth lumbar), and anterior divisions of upper three sacral and branch of fourth sacral nerves. All these unite in one flat cord, which rests on pyriformis muscle under pelvic fascia.

Its branches are :

Muscular.		Pudic.
Superior gluteal.	|	Small sciatic.
Inferior gluteal.	|	Great sciatic.

1. *Muscular* branches supply pyriformis (arises from plexus or upper sacral nerves before they unite), obturator internus and gemellus superior (arises at junction of lumbo-sacral cord with first sacral, leaves pelvis at great sacro-sciatic foramen, passes over ischial spine, and re-enters pelvis by small foramen), gemellus inferior and quadratus (from upper part of plexus, passes out through great foramen to course down under gemelli and obturator internus to supply quadratus on anterior surface).

2. *Superior gluteal*, from back of lumbo-sacral cord and first sacral, leaves pelvis through great foramen above pyriformis with gluteal vessels, and divides into

two branches—*superior*, to gluteus medius, and *inferior*, which goes between gluteus medius and minimus, supplies them, and ends in tensor vaginæ femoris.

3. *Inferior gluteal*, from lumbo-sacral cord, first and second sacral (intimately connected with small sciatic), leaves pelvis under pyriformis, supplies it and gluteus maximus, and gives a cutaneous branch to buttock.

4. *Pudic*, from lower part of plexus, emerges below pyriformis, crosses ischial spine, and re-enters pelvis by small sacro-sciatic foramen. It then accompanies pudic vessels along outer wall of ischio-rectal fossa, in sheath of fascia (*Alcock's canal*), and divides into perineal nerve and dorsal nerve of penis. Its branches are :

(a) *Inferior hæmorrhoidal* to integument round anus (see p. 52).

(b) *Perineal*, which accompanies superficial perineal artery and divides into *anterior* and *posterior cutaneous* branches (see p. 52), and *muscular* to transversus perinei, bulbo-cavernosus, ischio-cavernosus, and compressor urethræ. The branch to the second named muscle gives a *nerve to the bulb*.

(c) *Dorsal of penis*, runs with pudic artery, pierces both layers of triangular ligament and runs to glans along dorsum of penis with dorsal artery ; it gives a branch to the corpus cavernosum.

5. *Small sciatic*.—From second and third sacral, leaves pelvis below pyriformis, descends with sciatic artery under gluteus maximus, then along back of thigh to lower part of popliteal space, where it pierces deep fascia, and extends to middle of leg with external saphenous vein. All its branches are *cutaneous*, and arranged in three sets, *internal*, to skin at upper and inner side of thigh (one of these, the *inferior pudendal*, curves forward below tuber ischia to perineum*) ; *ascending* to buttock, and *descending* to back of thigh, popliteal region and upper part of leg.

6. *Great sciatic*.—This, the largest nerve in the body, is the continuation of the plexus. It leaves pelvis below pyriformis and descends between great trochanter and tuber ischii along back of thigh, dividing, at a variable height, into *internal* and *external popliteal* nerves.

* See page 52.

Before dividing it gives *articular* branches to hip and *muscular* to biceps, semi-tendinosus, semi-membranosus, and adductor magnus.

(a) The Internal Popliteal Nerve

descends through middle of popliteal space, crossing the artery from outer to inner side, to lower border of popliteus, where it becomes *posterior tibial nerve*. Its branches are : Three *articular* accompanying azygos and internal articular arteries ; *muscular* four or five to gastrocnemius, plantaris, soleus, and popliteus (that supplying latter muscle turns round its lower border), and *ramus communicans tibialis*, which joins *ramus communicans peronei* to form *external* or *short saphenous* nerve ; this nerve runs with external saphenous vein down leg at outer margin of tendo-Achillis, winds round outer malleolus, and supplies skin along outer side of foot and little toe.

The *posterior tibial* nerve passes with posterior tibial vessels on deep muscles of leg to inner malleolus, behind which it divides into *internal* and *external plantar* branches. It is first to inner side of artery, but soon crosses it to outer side. Branches : *muscular* to tibialis posticus, flexor longus digitorum and longus hallucis ; *plantar cutaneous* to heel and inner side of sole ; and *articular* to ankle joint.

The *internal plantar* corresponds to the median in the hand. It accompanies internal plantar artery along inner side of foot, first under abductor hallucis, then between that muscle and flexor brevis digitorum, dividing at bases of metatarsal bones into four digital branches. Its branches are : *cutaneous* to sole, *muscular* to abductor hallucis and flexor brevis digitorum, *articular* to tarsal and metatarsal joints, and four *digital*. The *first* of which supplies inner border of great toe and flexor brevis hallucis ; the *second* supplies adjacent sides of great and second toes and first lumbrical muscle ; the *third* supplies adjacent sides of second and third toes and second lumbrical ; the *fourth* supplies adjacent sides of third and fourth toes.

The *external plantar* nerve corresponds to the ulnar in the hand. It accompanies external plantar artery across the foot between flexor brevis digitorum and

flexor accessorius. Between former muscle and abductor minimi digiti it divides into two branches; the *superficial* gives two *digital* nerves, one to outer side of little toe, flexor brevis minimi digiti, two interossei of fourth interosseous space, and one to adjacent sides of fourth and fifth toes. The *deep* branch accompanies artery under *flexor* tendons and adductor hallucis, and supplies remaining interossei, two outer lumbricales, and adductor transversus and obliquus hallucis.

(b) The External Popliteal or Peroneal Nerve

passes down along inner margin of biceps, winds round head of fibula, pierces origin of peroneus longus, and divides into anterior tibial and musculo-cutaneous. *Branches*: Three *articular*, accompanying anterior tibial recurrent and external articular arteries, *cutaneous* to skin on back and outer part of leg, and *ramus communicans peronei*, which helps to form short saphenous (*vide suprâ*).

The *anterior tibial* nerve passes forwards under extensor longus digitorum to interosseous membrane and descends on anterior tibial artery to ankle-joint, where it divides into external and internal branches. It supplies offsets to the ankle-joint, tibialis anticus, extensor longus digitorum, peroneus tertius and extensor proprius hallucis muscles.

The *external* or *tarsal* branch passes outwards under extensor brevis digitorum and supplies it and the articulations of the tarsus, having become ganglionic. It gives three fine *interosseous* branches to tarsal and metatarsal joints of second, third, and fourth toes. The *internal* branch accompanies dorsalis pedis artery, and divides into two branches to adjacent sides of first and second toes and first dorsal interosseous muscle.

The *musculo-cutaneous* nerve passes between peronei and extensor longus digitorum muscles, pierces deep fascia at lower third of leg (giving branches to skin and peroneus longus and brevis), and divides into *internal* and *external* branches. The former supplies inner side of great, and adjacent sides of second and third toes, the latter the adjoining sides of third, fourth, and fifth toes.

C.—The Sympathetic Nerves.

The sympathetic nervous system consists of the following parts :

(1) *Gangliated cords* from base of skull to coccyx on either side of vertebral column.

(2) Three *gangliated plexuses* in thoracic, abdominal, and pelvic cavities respectively.

(3) Smaller *ganglia* in relation with abdominal viscera.

(4) *Communicating and distributing* nerve fibres.

These will be briefly considered under two heads.

1. THE GANGLIATED CORDS.

These pass down on either side of middle line. They may be traced upwards in a plexus on internal carotid artery to join (according to some anatomists) at the *ganglion of Ribes* on anterior communicating artery. The parts of the two cords are named thus, according to their position :

Cervical—3 pairs of ganglia—in front of vertebral transverse processes.

Dorsal—12 pairs of ganglia—in front of heads of ribs.

Lumbar—4 pairs of ganglia—on sides of vertebral bodies.

Sacral—4 or 5 pairs of ganglia—in front of sacrum.

In the pelvis they unite in front of coccyx at *ganglion impar*. The communicating branches of the ganglia are both white and gray fibres, the former passing from spinal nerves to ganglia, the latter in the reverse direction.

(a) Cervical Portion

has three ganglia, superior, middle, and inferior.

Superior cervical ganglion, placed opposite second and third (sometimes fourth and fifth) vertebral transverse processes. It is fusiform in shape, and it lies under carotid sheath on rectus capitis anticus major muscle. Its *superior branch* enters carotid canal, and divides into two divisions on internal carotid artery, to go to carotid and cavernous plexuses. The *inferior branch* passes to middle cervical ganglion. The *external*

branches communicate with ganglion of trunk of vagus, hypoglossal, and upper four spinal nerves. The *internal branches* are *pharyngeal* to pharyngeal plexus, *superior cardiac* which pass, the *right* to deep cardiac plexus, the *left* to superficial cardiac plexus. The *anterior branches* ramify on external carotid artery and its branches, communicating with facial nerve, otic ganglion, and geniculate ganglion of facial (by external petrosal nerve).

Carotid plexus, lies on outer side of internal carotid and communicates with Gasserian ganglion, sixth nerve, sphenopalatine ganglion (by *large deep petrosal*), and Jacobson's nerve (by *small deep petrosal*). It supplies dura mater and the artery.

Cavernous plexus, lies on inner side of internal carotid as it lies in cavernous sinus. It communicates with third, fourth, fifth, and sixth nerves, and ophthalmic ganglion (with nasal nerve), and supplies internal carotid.

Middle cervical ganglion, or *thyroid ganglion*, lies opposite sixth cervical vertebra on inferior thyroid artery. It may be absent. Its branches are: *Superior* to superior ganglion, *inferior* to inferior ganglion. *External* to fifth and sixth spinal nerves (not constant), *internal*, two to thyroid body and deep cardiac plexus. The last is the *middle* or *great cardiac nerve*.

Inferior cervical ganglion lies between base of seventh transverse process and neck of first rib on inner side of superior intercostal, and behind vertebral artery. It may be joined by first thoracic ganglion and gives following branches:

Superior to middle ganglion, *inferior* to first thoracic ganglion.

External to seventh and eighth spinal nerves, and some on vertebral artery, which communicate with cervical nerves as high as fourth.

Internal or *inferior cardiac nerve* to deep cardiac plexus.

(b) Thoracic Portion.

These ganglia may be twelve or less (from coalescence of two or more) in number, each lying on the head of a

rib. They are connected by intervening cords, and each ganglion gives the following branches :

External, two to communicate with each spinal nerve. *Internal*, of which those of *upper six* are small and supply aorta, and vertebræ and their ligaments. Branches from third and fourth go to posterior pulmonary plexus. The *lower six* are large and white, and form the *splanchnic nerves*.

Great splanchnic nerve, formed by branches from sixth to tenth ganglia ; it perforates crus of diaphragm and ends in semilunar ganglion, giving filaments to renal and suprarenal plexuses.

Lesser splanchnic nerve, formed by branches from tenth and eleventh ganglia, and cord between them. Piercing diaphragm with great nerve, it joins coeliac plexus, and sometimes sends filaments to renal plexus.

Smallest or renal splanchnic nerve, from last ganglion, pierces diaphragm and ends in renal plexus and lower part of coeliac plexus.

(c) The Lumbar Portion.

This part lies in front of vertebræ, along inner margin of psoas muscle. It has four ganglia, connected by cords, and from each of the former are given the following branches : *Superior* and *inferior* to ganglia above and below ; *external*, two communicating with each lumbar spinal nerve, and *internal* to aortic and hypogastric plexuses, and to supply vertebræ and their ligaments.

(d) The Pelvic Portion

lies in front of sacrum, along inner side of anterior sacral foramina. It has four or five ganglia, connected by cords. Their branches are : *Superior* and *inferior* to ganglia above and below ; *external*, two to communicate with each sacral nerve, and *internal* to pelvic plexus and coccygeal (Luschka's) gland.

2. THE GREAT PLEXUSES.

These are aggregations of nerves and ganglia situated in thoracic, abdominal, and pelvic cavities, from which branches are derived to supply the viscera.

(a) The Cardiac Plexus.

The cardiac plexus is divided into two parts, superficial and deep.

The *great* or *deep cardiac plexus* lies behind aortic arch, in front of bifurcation of trachea. It is formed from the three cardiac nerves from cervical sympathetic (except left superior cardiac nerve), and cardiac branches of recurrent laryngeal and vagus nerves (except left inferior cardiac branch of vagus). *Branches* : From *right* side to anterior pulmonary plexus, pulmonary artery, and anterior and posterior coronary plexuses. From *left* side to anterior pulmonary plexus, posterior coronary plexus, and superficial cardiac plexus.

The *superficial* or *anterior cardiac plexus* lies beneath aortic arch, in front of right pulmonary artery. It is formed by left superior cardiac nerve, left (and occasionally right) inferior cardiac branches of vagus, and filaments from deep cervical plexus. A small ganglion (*cardiac ganglion of Wrisberg*) is sometimes found in the plexus on right side of the ductus arteriosus. The *branches* form chief part of anterior coronary plexus, some going to left anterior pulmonary plexus.

(b) The Epigastric or Solar Plexus.

This plexus lies behind stomach on aorta and crura of diaphragm, surrounding coeliac axis and origin of superior mesenteric artery. It supplies all the abdominal viscera, and extends as low as pancreas and as far out as suprarenal bodies. It receives both great splanchnic nerves and filaments from right vagus. Its two *semilunar ganglia* are the largest in the body. They lie on the diaphragmatic crura close to the suprarenal bodies, the *right* one under superior vena cava. Each is connected internally with the solar plexus, and receives a great splanchnic nerve. From the solar plexus are given branch plexuses which follow the branches of the aorta and supply viscera. They are :

(1) *Phrenic* or *diaphragmatic plexus*, which receives branches of phrenic nerve; the junction on the right side has on it a ganglion (*ganglion diaphragmaticum*).

(2) *Suprarenal plexus*, which receive branches from great splanchnic and phrenic nerves.

(3) *Renal plexus*, joined by filaments from lesser and smaller splanchnic nerves, and communicating with spermatic plexus.

(4) *Spermatic plexus* (*ovarian* in female), derived from renal plexus.

(5) *Celiac plexus*, the direct continuation of solar plexus. It receives branches from lesser splanchnic nerves, and, on the left side, branches from right vagus. It subdivides into *gastric* (or *coronary*), *hepatic*, and *splenic* plexuses. The hepatic plexus receives filaments from left vagus and right phrenic nerves and gives branch plexuses corresponding with the branches of hepatic artery. The *splenic* plexus receives twigs from the right vagus and the *gastric* receives branches from left vagus.

(6) *Superior mesenteric plexus* receives a branch from right vagus, and is the continuation of lower part of solar plexus. It supplies branches corresponding with those of superior mesenteric artery.

(7) *Aortic plexus* lies on sides and front of aorta, receiving branches from semilunar ganglia, renal and solar plexuses, and gives rise to *inferior mesenteric*, part of *spermatic*, and *hypogastric* plexuses. The *inferior mesenteric plexus* gives the following secondary plexuses : *left colic*, *sigmoid*, and *superior hæmorrhoidal*.

(c) The Hypogastric Plexus.

This supplies pelvic viscera. It lies on sacral promontory, between common iliac arteries, being formed from aortic plexus and lumbar ganglia. It contains no ganglia, and divides into two lateral *pelvic plexuses*.

(d) The Pelvic Plexus.

The pelvic or *inferior hypogastric plexus* lies at side of rectum and bladder. From it branch plexuses pass with those of internal iliac artery to all the pelvic viscera as follows :

Inferior hæmorrhoidal, *vesical* (which communicates with spermatic plexus), and *prostatic* plexuses. From

the prostatic two nerves, *large* and *small cavernous*, pass to fibrous covering of penis and corpus cavernosum and spongiosum.

In the female there exist also *vaginal* and *uterine* plexuses.

THE END.



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